LATERAL CURVATURE OF THE SPINE

LATERAL CURVATURE OF THE SPINE

AND

PELVIC DEVIATIONS

BY

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PREFACE

THOUGH appearing as a sixth edition of my earlier work on 'Lateral Curvature of the Spine,' this book is entirely re-written, and sets forth certain facts, which I discovered in and about 1890, which constitute the key to the problem of spinal curvature, and which form the rational basis to effective treatment.

In dealing with this last subject, it was necessary to point out how and why many forms of treatment hitherto and still used are frequently misdirected; some of these are mentioned in Chapter IV., but I must beg my professional brethren not to commute criticism of methods into censure of men, which they probably will be less disposed to do when I frankly confess, that before my detection of certain pelvic malpostures I also erred in believing, that treatment must be directed solely to the spine.

Since that period I have expended much time and thought in devising and testing modes of treatment, aimed directly at the deforming influence of certain pelvic malpostures, at strengthening weakened and at elongating shortened muscles. Also I have advocated certain methods of so specializing treatment, that it may really affect the part of

the anatomy aimed at, and may not encroach on other parts where its influence can only be injurious.

The result of much labour is given as succinctly as is compatible with facile reading and comprehension in the ensuing pages.

RICHARD BARWELL.

WIMPOLE STREET,
December, 1904.

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LATERAL CURVATURE

CHAPTER I

DIAGNOSIS

THE early phases of lateral curvature are, as a rule, amenable to properly-directed treatment of moderate duration. Later stages are with difficulty curable, and this only after somewhat prolonged attention. Thus the importance of timely recognition is self-evident, but very often the parents and surroundings of young people fail to perceive that anything is amiss until the deformation has reached a degree regrettably visible even through garments.* Other parents are more observant, or some chance good fortune guides attention in that particular direction. Even when the family attendant examines the back a slight curve may yet be overlooked, because some experience is required for its detection, and because the signs to be especially observed are not within the common knowledge of even very excellent practitioners. I begin, therefore, with diagnosis, and must at the outset observe that to look merely or even at first at the line of spinous processes is the worst way of examining a suspected spine, because as will be fully explained in the sequel, a certain twist of the vertebræ, technically called rotation, is an inevitable

* Very often the dressmaker is the first to acquaint parents of a crooked condition.

concomitant of every sideways bend, whether voluntary or otherwise. This rotation takes place in such direction that what normally is the front of each centrum faces towards the convexity of the curve, and the tips of the spinous processes glide towards the concavity. Thus that row of prominences is in early stages of scoliosis straight, or nearly so, while in fact the column, especially

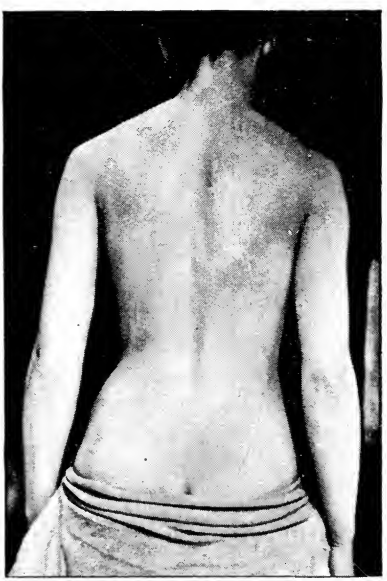


FIG. 1.—LUMBAR CURVE TO RIGHT.

its front portion curves very considerably. The parts to which attention should be primarily directed are the two side outlines, and they must be compared one with the other. The differences between them reveal chiefly, of course not solely, the presence and amount of lateral deviation, for these margins are deficient in rotundity, or in severe cases are actually hollow opposite concavities,

too full and rounded opposite convexities of the laterally curved spine. Beginning with the simplest kind—lumbar* and total curve—Fig. 1 represents the former of these conditions,† but to the right, instead of the more common left variety. On the left the side outline of the chest-wall, traced from the axilla downward, is very

FIG. 2.—TOTAL SIMPLE CURVE TO LEFT.

slightly convex; its lower part curves abnormally inward to the waist, where the edge of the figure approaches much nearer to the middle line than does that of the other side; or, as I prefer to express it by a word, I may be permitted to coin, the 'incavation' of the waist is exaggerated. This gives a fallacious appearance of undue prominence

* This term is not quite accurate; curves, so called, involve also the last three or sometimes the last four dorsal vertebræ.

† The figure also shows that even in very crooked backs the line of spinous processes may be straight.

to the hip, though, in truth, it does not really protrude more than the other, but the hollowness of outline just above it throws it (the crest of the ilium) into strong relief. On the right (convex) side the thoracic outline is somewhat more rotund, and the incavation of the waist but slightly marked. The interspace therefore, between the margins

FIG. 3.—TOTAL SIMPLE CURVE TO LEFT.

of the trunk and the symmetrically pendent arms, is much narrower on the convex than on the concave side ; also, it is less triangular in form.

Simple total curvatures combine the signs of lumbar with those of dorsal curvature ; but it must be noted that both these are on the same side.* The above figure represents such a case. The angular incavation of the

* In the very common lumbo-dorsal (S-shaped) curve the indications of convexity are at one side in the lumbar, at the other in the dorsal region, as explained in the sequel.

waist (whence the deceptive appearance of projecting hip) is on the right side, and so also, contradistinguishing it from the previous figure, is the hollow outline of the thorax, while rotundity of chest margin on the left coincides as to side with comparatively inconspicuous hip prominence; or, otherwise stated, the two segments are not separated on the left by a deep, almost angular, interval, the crest of the ilium is not clearly distinguishable, but rather chest and pelvic outlines merge into one another. This semeiology is more clear in Fig. 3. All the changes of outline, described in the last few paragraphs, are caused by lateral deviation; another element of scoliotic deformation (rotation) manifests itself by changes on the surface (see p. 8).

Though the initial phases of curvature are nearly always either lumbar or total, yet the most usual type, as it comes under observation, is the so-called **S** curve*—namely, a twofold curve, having one direction at the lower, the contrary at the upper part of the figure. Most commonly these curves are lumbar to the left, dorsal to the right. In about one case in six the directions are reversed. The pathognomonic signs on the side outlines of such curvatures are as follows: The right shoulder and arm sit very close to the chest, the left ones further away; on the former side the arm is so sessile that the outline of the chest overlaps and conceals the contiguous margin of the limb.† On the latter side there is even immediately at the axilla a wider interval between arm and trunk. The right chest outline is somewhat rounded, sloping inward as far as the level of the ninth dorsal vertebra, and there makes a distinct angle with the outline of the pelvic segment, marking well the prominence of the hip. The outline on the left side, taking it as a whole from armpit to the top of the thigh, is

* For description of the change from the two first-named kinds of curvature to the lumbo-dorsal, or **S**, see Appendix VII., p. 100.

† See Fig. 6 for full development of this condition.

one hollow curve, crescentic in form. The pendent arms leave, between them and the trunk, intervals which on the two sides differ much in shape. On the right, owing to that sessile condition of arm above mentioned, the clear gap, through which one can see, does not extend nearly as

FIG. 4.—LUMBO-DORSAL CURVE.

high up as on the left; it is for some way down narrower, then broadens, and for a distance above and below the waist is wider than any part of the left interval, also it is distinctly triangular, while the brachio-somatic interval on the left side has the form of a slightly curved crescent. These descriptions apply to by far the larger

percentage of cases; but they must be supplemented by some notice of a minority, and of the varieties that occasionally are met with. Probably, however, the reader will hardly care to be troubled with more descriptive matter, than is necessary to explain the subject; it may therefore suffice to subjoin here two more figures.

The first represents a well-marked, though not a severe,

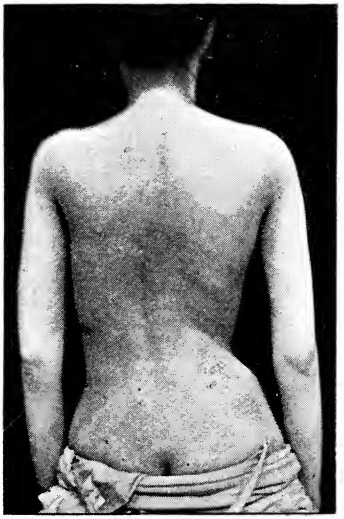


FIG. 5.—SEVERE LUMBO-DORSAL CURVE, THE POINT OF INFLEXION UNUSUALLY HIGH.

curvature. Its side outlines corroborate the descriptions just given. It represents a more advanced curvature, and is introduced (Fig. 5) as showing that an occasional variation may to a certain extent modify the outlines, but not sufficiently to embarrass diagnosis. Encroachment of the left lumbar curve very high into the dorsal segment has caused the margin of the chest-wall below the sixth vertebra (at which level is the point of inflexion) to bulge,

though at the axilla it starts with the usual scoliotic concavity. The second of these plates shows a more severe curvature. All the characteristics here so marked may be traced in embryo in Figs. 4 and 5, serving to emphasize the importance of recognising by these means the signs of curvature before it has reached such regrettable results.

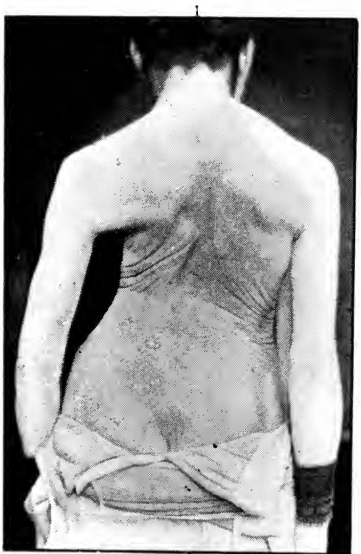


FIG. 6.—SEVERE LUMBO-DORSAL CURVE. THE ANGLES OF THE RIGHT RIBS VERY SHARP.

As already stated, asymmetry of side outlines notifies lateral deviation. The other element of scoliosis—rotation—is marked by changes of form on the surface of the loins and back. Attention may at once be directed to backward protuberance of the right ribs as far down as the tenth; below it the lumbar surface becomes flat or hollow. On the left side it is the thorax that is shrunken, the loin that is

full. This asymmetry is due to propulsion of the ribs forward on the left (concave), backward on the right (convex), side. Those movements affect the position of both scapulæ, which, when a person stands straight like a soldier in ' attention ' attitude at drill, lie normally so on the posterior chest-wall that their dorsa look directly backward ; but in scoliosis, movement forward of the left ribs deprives the blade of its substratum : it therefore falls in, and so inclines that its dorsum faces a little inward, and even downward ; its angle ceases to make prominence on the figure ; it also shifts nearer to the spine. On the right the backward progress of the ribs pushes in the same direction the lower angle of the scapula, which, therefore, now becomes an exaggerated projection, while the back of the bone looks outward and a little upward.* In advanced cases the angles of the ribs become much too sharply bent (Fig. 6), and, lying one above the other, form a blunt, prominent ridge parallel to, but at some distance from, the row of spinous processes. In such event the scapula is still more displaced, its posterior surface looking more outward than backward (see Fig. 6). Further reference must be made to the loin, which, be it remembered, curves in a direction contrary to that of the dorsum—viz., to the left ; thus about the level of the ninth vertebra the parts at the right side of the spine, instead of protruding, as they do, higher in the figure, are flat or hollow, almost forming a shallow groove at the side of the spinous processes, while on the left (convexity) this same region is full and rounded. These appearances also are the necessary sequelæ of rotation ; the transverse processes on the right side, shifting forward, have drawn the muscles and other soft parts in the same direction ; thus they lose their firm substratum. On the left side the absolutely contrary occurs ; there

* It is these postures that cause one arm to look, as above described, more sessile on the side of the chest than the other.

those bony projections pass backward, push thither the soft parts, and afford a more proximate support to the muscles. That this is the real cause of the apparent increase in size of the left erector spinæ can be verified by palpation,* for on the right the fingers sink easily into the unsupported parts—into, as it were, a sense of void; on the left side they are firmly resisted. Moreover, by pressing the finger-ends just outside the edge of the ilio-costalis muscle, at first forward and then a little inward, the tips of the transverse processes can easily be felt lying much too near the surface. On the right (concave) side no such can be detected, even with much stronger pressure.

A very characteristic surface-marking is noticeable in Fig. 5. It is seldom so strongly marked as in that photo, but is very rarely entirely absent. Just above the crest of the ilium on the right is a somewhat broad triangular shadow, marking a depression of the surface, caused by the above-described forward progression of the transverse processes and lowest (false) ribs; the soft parts follow in the same direction, and in this particular figure so markedly that the skin seems almost stretched over the edge of the ilium, and shows it up very strongly and sharply.† If this triangular shadow be imperceptible in the usual way of lighting—so directly opposite a window that the light falls vertically to the plane of the figure—it may be brought into view by turning the patient a little sideways.

Oblique lighting is also very useful for revealing the unobtrusive prominences and depressions of initial curvature. These are generally so gradual that they neither cast shadows nor receive high lights if the illuminant be straight

* I have received a goodly number of letters from medical men to whom I have written about their patients, sent to me, asking if I had noticed the over-action of the loin muscles on the convex side.

† The lumbar curve in this patient was especially sharp at the lower part of that region.

behind, but show out plainly, if the patient be turned sideways. Diagnosis may be corroborated by the following method : The surgeon, standing at the patient's side, should so stoop his head as to bring his right eye close to

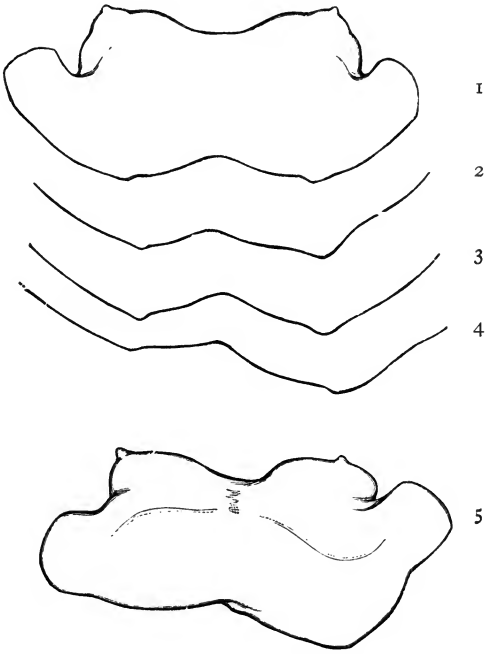


FIG. 7.—SECTIONS OF THE TRUNK ABOUT SEVENTH DORSAL VERTEBRA.

1, Normal ; 2, 3, 4, 5, Increasing Rotation.

the vertebra prominens, and should look down the spine as along a gun-barrel. By moving his head a little nearer to, or further from the patient he may view this part of the figure at every level, and compare rotundity or concavity

of one side with the like or contrary condition of the other. Very small asymmetry can thus be detected and verified.

The outlined views of the back thus examined are depicted diagrammatically in Fig. 7. The first section (whole) is normal; the next three show increasing phases of rotation; the fifth (whole), a severe case. The patients were seated on a low stool; the draughtsman stood on a much higher one, so as to look perpendicularly down. For clearness' sake the head has been omitted.

CHAPTER II

PELVIC DEVIATIONS

SINCE, perhaps even before, the time of Hippocrates—that is, for about 2,500 years—lateral curvature of the spine has been attributed solely to defects in the column itself, and yet that ascription is erroneous. This little work is designed to show what, in the vast majority of cases, is the real origin of the malformity, and to indicate forms of treatment which, by eliminating its cause, remedy the evil. Facility of comprehension will, however, be promoted by some description of how I was led to detection of the cause.

When, in 1865, I first turned my attention in this direction, I perceived that in a by no means small precentage of cases one limb was shorter than the other. This condition may easily be detected by directing the patient to stand in drill posture,* while the surgeon at her back places the index of each hand on the crest of the ilium at the side outline of the figure. If one limb be short, the iliac crest of that side will be on a level lower than the other; the recognition of the defect is rendered more certain, if some distance in front of the patient a horizontal line, such as the edge of a table or a dado, be brought to correspond in the line of sight with one of the surgeon's

* This means standing with the feet together, both knees straight, the arms hanging loosely and symmetrically by the sides.

indices, and by observing whether the other is also on the same level as the horizontal line. Difference in length of limb is not infrequently produced by unilateral deficiency of growth, certain possible, even probable, causes of which need not here be investigated. Suffice it to say that often no ascribable cause can be detected, the unevenness seeming to depend on the same sort of irregularity as causes in some persons crookedness of the features. Former disease of a lower limb joint is in other cases the easily-detected cause. In the instance depicted (Figs. 8 and 9) the lad only came under my care when the shortening had lasted some time. My efforts were almost limited to obviating the effect on the spine of the inequality. That effect, unopposed, is—indeed, must necessarily be—as follows: The pelvis—*i.e.*, the base on which the spine is built up—slopes; therefore, if the column remained at right angles (laterally) to this oblique basis it would lean over to the lower side of the pelvis. But in such case the line of gravity would fall outside the patient's feet, and he could not possibly maintain his balance; therefore he instinctively restores equilibrium by throwing the trunk over in the contrary direction—that is, to the high side of the pelvis—thus producing a lumbar curve convex to the lower side of that bone.* If the condition be neglected, the curve becomes not merely positional, but persistent—that is to say, when the normal horizontality of the pelvis is restored the spine is incapable of correcting itself, even though the patient use his utmost efforts. Yet, if proper precautions to prevent such result have been taken, the column straightens itself, without any exertion on the part of the patient, as soon as the pelvis is made level. The

* In the sequel will be explained that such curve sometimes continues also through the dorsal region (simple total curve); in other cases the curve of that region is in a direction contrary to that of the loins (lumbo-dorsal curvature).

necessary conclusion, to be drawn from this sequ[illegible] events, is that the spinal deviation is due solely to pelvic malposture.

This form of limb inequality, whether produced by irregularity of growth or by joint disease, I have termed

FIG. 8.—LIMB SHORTENED BY HIP DISEASE.

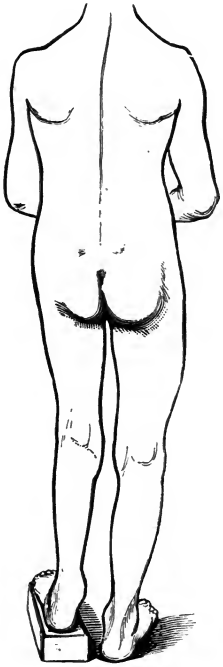


FIG. 9.—PELVIS MADE LEVEL.

'permanent pelvic obliquity,' in order to distinguish it from another condition which I call 'habitual pelvic obliquity.' This is a manner of standing much more common in females than in males. No one as a rule assumes, as a more or less constant attitude, the drill

indices, and rather throws the body-weight on one limb, which is kept straight while the other is flexed, and bears only such a proportion of the weight as will insure balance. If sometimes one, sometimes the other limb be used to support the body-weight, no harm results; but if station be always on the same, the effect is like that of permanent

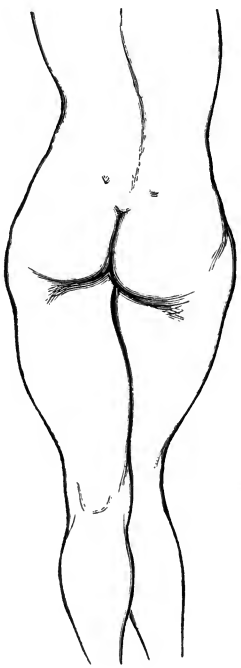


FIG. 10.—HABITUAL PELVIC OBLIQUITY.

pelvic obliquity. Probably the feminine mode of dress—skirts concealing the attitude of the limbs—facilitates the assumption of an attitude, which a creature in trousers would be rapidly laughed out of. I have on several occasions distinctly traced the defective position to unilateral ovaralgia.

For a certain period my investigation of pelvic malposture stayed at this point. In looking back over some years of work, it now seems to me strange that the possibility of other defective attitudes should not have occurred to me; they were however revealed in the following manner: In 1888 I devised an instrument for measuring the amount of rotation and of lateral deviation in spinal curvature. It carried a horizontal bar, permitting no other movement than elevation and depression, so that it might be on both sides in contact with the superior posterior spines of the ilium. The upper parts of the instrument, which need not here be described, measured not only sideways deviations of the spine, but also asymmetrical projection or depression of adjacent parts. To use these parts it was essential that the lower bar just described should lie fair and square against the back of the pelvis; but soon I found that in the great majority of cases this object could not be attained. In some the mid-line of the pelvis lay on one side of the central point of the instrument, in others one ilium only came in contact with the bar, the other standing away at greater or less distance. Thus it was plain that I had to do with two hitherto unsuspected conditions—one in which the pelvis was not vertical over the interval between the feet, and also one in which it was so twisted that one side lay further back than the other. Verification of these postures required, however, more precise demonstration.

The habit of surgeons, examining a suspected back, has always been to denude the figure down to the level of the hips, a plan, which though it reveals the spinal aberration, conceals the cause. Thus I was led to expose larger portions of the figure, and at the same time to use photography, so that on the completed print accurate geometrical measurement with square and compass might be made available. Difficulties with regard to garments still ob-

structed me. For instance, Fig. 11 shows my most successful attempt to obtain a useful view with as little denudation as possible. We can in this figure demonstrate the lateral position of the pelvis; but another measurement (to be described immediately) is impossible: patients, feeling their garments slip downwards, catch at and shift them, often at the very moment, when the picture is being taken. Though in this particular instance the feet and legs in dark shoes and stockings are shown, yet it often happens, if the day be rather dark, or the lower part of the skirt cast a deep shadow, that no image of them is obtained. In these ways I got so many failures, disappointing to self and patient, that I devised a plan whereby, without indelicacy, I could obtain a picture of the whole figure.

Firstly, it is necessary that the camera be so placed as to stand accurately square behind the figure,* and a fixed line, whence measurements are to be taken must be arranged. On the floor is laid a piece of white tape, 4 or 5 feet long. At both ends it is fixed by carpet-pins, which at the same time secure loops at each end of a piece of string, in the exact middle of which is a knot. At a point on the tape equi-distant from both carpet-pins a sufficiently conspicuous peg is stuck into the floor. Thus is procured an isosceles triangle: its base is the tape, its apex the knot in the string. The camera (of course on a stand) is so placed, that the centre of the lens corresponds with the knot in the string; and thus it is evident, that if anyone stand at the tape with the heels equi-distant from the central peg, light rays, reflected from that person's figure to the lens, must be at right angles to the coronal plane of the figure.

All being thus arranged, I show the patient how to place the feet at the tape on each side of the peg; behind a screen

* Cross lighting will, of course, be avoided.

the clothing is removed, and the body covered with a large shawl or cloak. When the prescribed position has been

FIG. 11.—DIFFICULTIES WITH GARMENTS.

taken up, I verify that the feet are accurately in place, turn my back, and let the cloak be removed by mother or friend. The plate having been exposed, the covering is

resumed, and behind the screen the patient dresses. Thus I see the back of the figure, and that only as a photographic print like those here reproduced.

The narrow white line at the heels is the tape above mentioned, and represents the true horizontal; a straight figure should stand upon it absolutely vertical, and by means of a square, correctness or aberration of position can be actually measured.*

In Fig. 12 a perpendicular has thus been drawn. Instead of running up in the middle of the interspace between the two lower limbs, it passes over the inside of the calf, the back of the knee and thigh, running also considerably to the left of the median intergluteal fissure. Evidently, therefore, the nether limbs do not stand vertically to the floor, but slope obliquely to the right. Therefore, as that part of the figure deviates to one side, the condition may aptly be named pelvic amesiality, and the adjective right or left, according to the direction of the defect, may be appropriately applied. This figure also serves to show how early such malpostures may begin; it has, however, been so recent that the evil effects on the spine, though quite perceptible, are still in such phase as to be easily overlooked. Another example, that of a youth about seventeen years old, may also be given. Many more such pictures might be added, but the very many photographs in my possession cannot be reproduced without overloading these pages. I mention their abundance because certain writers, chiefly from abroad, while admitting the existence of such a condition, say it must be

* A caution must here be interpolated: those parts of the picture which are refracted by the margin of the lens suffer spherical aberration; hence the white line on either side of its central point is a little bent. The steel square, therefore, must not be used unaided on this line, but a flat metal ruler must be so placed upon it that its edge corresponds to both ends of the line; and against its margin the square a[illegible]s on the figure.

extremely rare. It is, on the contrary very common, and the reason why to some it seems unusual is, that such

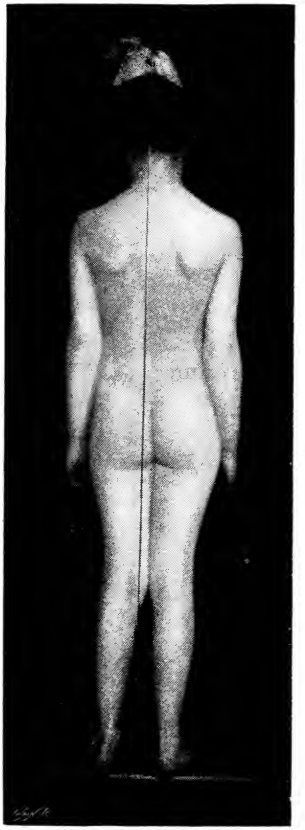


FIG. 12.—PELVIS AMESIAL TO RIGHT.

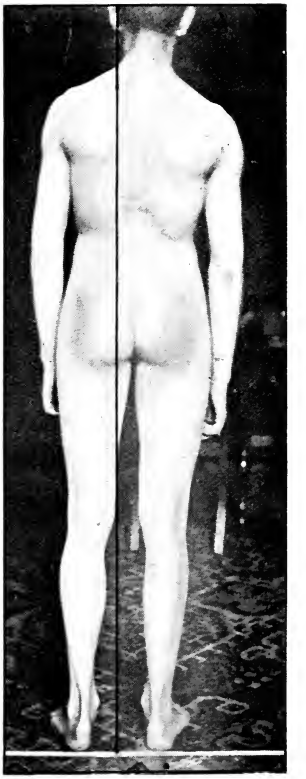


FIG. 13.—PELVIS AMESIAL TO RIGHT.

persons have not looked for it, apparently because they have not known how to do so.

Nevertheless, another injurious posture is still more

prevalent ; it consists of a twist of the pelvis, which throws one side further back than the other. Fig. 14 is taken from one having this defect in a very marked degree. A mere glance shows that the left side of the pelvis is depicted as very much broader than the right ; not that it really is so, or that the left innominate bone is bigger than its fellow ; but the view taken by a camera vertically behind the patient is entirely different on the two sides. On the one (in this instance the left) the broad lateral face of the pelvis is represented ; on the other merely its hinder aspect, and even that very much foreshortened.* This figure is presented here as the simplest way of explaining what pelvic version is, but the very common malposture should however also be shown in its more usual degrees. Fig. 15 is an example of a very frequent amount of version, while a milder phase of the same, also to the left, is shown in the third of this series. The reader may be requested to note while examining these pictures, that in all, one side of the pelvis not only looks much wider than the other, but also that on measuring with a compass from the intergluteal fissure to the side outlines an absolute geometrical demonstration of the condition is obtainable. Moreover in consequence of the side view which, as just stated, the camera takes, the post-trochanteric fossa of the verted side is broad, one sees straight into it, while on the other side it is only depicted obliquely, and therefore looks narrow.

Certain other peculiarities of this malposture facilitate diagnosis by an attendant, who may not be conversant with photographic manipulations. The patient, clothed or with only outer garments removed, stands in drill posture,

* It might at first be thought that this pelvis is oblique ; that such is not the fact is proved by the vertical position of the rima natium. A very slight and deceptive appearance of slope is due to overlapping of the right by the left glutei.

and a spline or other straight-edge, from $2\frac{1}{2}$ to 3 feet long, is laid horizontally, so that its margin gently touches each

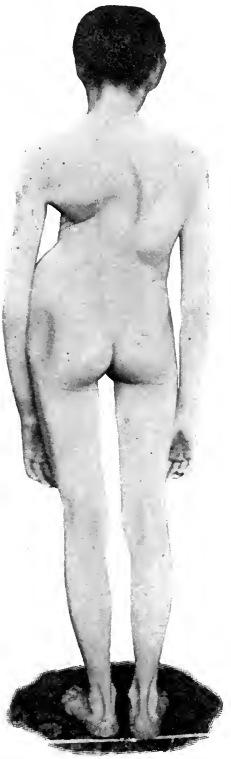


FIG. 14.—EXTREME LEFT VERSION.

FIG. 15.—PELVIC VERSION TO LEFT.

gluteus.* Observation will be surer, if a straight line in the pattern of the carpet can be made available, or, failing such, a white tape can be secured with carpet-pins; against

* Of course, precaution must preclude the possibility of garments or folds being thicker on one side than on the other.

either of these the patient's heels are to be placed. If the spline thus in contact with the patient's figure slope back at one or the other end the pelvis is twisted, or, as I have

FIG. 16.—PELVIC VERSION TO LEFT.

ventured to call it, 'verted' in that direction. While using this device, it is generally desirable to test the position of higher parts of the figure by simultaneously placing

another straight-edge across the back just below the blade-bone angles ; such indicators, if there be version, will not be parallel. The reader will perceive that such a twist of the pelvis, while the chest retains a normal frontal position, proves considerable rotation of the lower vertebræ.

There is still another way, by which version may be detected, for the malposture is not limited to the erect attitude, but is at least as marked while sitting, in which attitude it probably originates. In using this test, as the position of the knees is the index, the absence of growth irregularities must first be verified. The patient is to stand in drill posture ; close behind her a chair is placed ; she is bidden to sit down without looking round, and to keep the feet still. Then a straight-edge is placed horizontally in contact with both patellar ligaments ; if it slope back, one of the acetabula—that is to say, one side of the pelvis—lies on a plane posterior to that of the other side. In the absence of such general and chronic bone disease as rickets, and of a rare non-malignant form of mollities, the above-described malpostures of the pelvis—viz., obliquity, amesiality, and version—are in the very great majority of cases the starting-point and the efficient cause of lateral curvature. There are, however, a few cases originating in other conditions, which will now be specified.

Among the ranks of life, from which hospital patients chiefly come, curvature is often distinctly traceable to the habit of carrying burdens. These I have called in former publications ' weight-bearing curves.' A child or young person carrying inanimate objects employs either hand, and when fatigue in the one begins shifts the burden to the other ; but such children, especially if girls of about nine, ten and upwards, are very frequently employed in carrying about the younger children, doing so almost exclusively on the left arm, and to maintain balance throw the upper half of their trunk over to the right. Even

from these, however, must not be eliminated the influence of pelvic malposture, because, the more easily to carry the baby, the girl so stands as to shift her pelvis to the left—*i.e.*, under the burden—and unless she be very strong that posture is maintained afterwards, that is when the figure is no longer so loaded.

Indeed, any avocation enforcing persistent use during long periods of one hand and arm may, and, as I have seen by no means infrequently does, have injurious effects on the spine, and this even by what looks like the very light work of a seamstress. To set into the fabric rows of fine, equal stitches requires steadiness of the shoulder girdle, obtained chiefly by continued exertion of the serratus magnus. As the hours go by, as hand and forearm become fatigued, the more rigidly must the shoulder be held, which means more strenuous exertion of that powerful muscle, therefore more rotative action on the ribs, and through them on the spine (see Appendices IV., V.).

There is also a small percentage of cases due to troubles of the respiratory organs, to pleurisy, empyema, pneumonia, with hepatization, etc., on one side of the chest—in fact, to whatever may render breathing unilateral. The previous history and the physical signs at once reveal the causation.

CHAPTER III

ETIOLOGY OF PELVIC DEVIATIONS

THE etiology of ' permanent pelvic obliquity ' was necessarily included in its description ; the habitual form being ascribed either to mere trick or to a certain neurotic pain. But the other pelvic malpostures can with difficulty be traced back to their source, for two reasons : (1) They begin in very early life ; (2) their advent is so gradual that examination by a skilled observer takes place, only when the condition is so thoroughly established, that its source has become occult. Though well knowing, that what now immediately follows is incapable of complete proof, yet I venture to advance certain ideas, which a long and careful experience has taught me. Scoliosis is a trouble beginning early in life ; by far the larger number of persons seeking aid are between the ages of eleven and twenty ; some come under care much earlier. Several have been brought to me between five and seven, a few with weak backs, tending to curve rather than actually doing so, in the first year or year and a half of life. Thus the conclusion is inevitable that there may, or perhaps we should say there must be causes at work, even during infancy, that conduce to curvature. The flexible infantile spine, consisting almost entirely of soft cartilage, grows quickly, as also do the ligaments and muscles on each side ; therefore any external influence, which causes the body to bend persistently or very pre-

dominantly in one and the same lateral direction, is rapidly followed by shortening of those parts, which lie on the concave side. Many causes of such sideways inclination prevail in very early life. Every nurse invariably carries the infant on her left arm, which from elbow to wrist slopes downwards, and the baby's seat therefore is not horizontal ('sloping seat,' pp. 57 and 58). Moreover, the child instinctively seeks a safe support by leaning over to the right against the nurse's chest and shoulder—that is, it curves its lumbar spine to the left. The idea of security being on its right becomes so completely instinctive, that when the infant in the perambulator is falling asleep it constantly leans over in that direction. I have checked tendency to curve in several such babies by insisting, that for at least a week, it should be carried on the right arm, and after that period on either arm alternately; also that it should sleep on the left side, with a pillow placed crosswise under its loin.

Other pitfalls await the somewhat older child. The most dangerous is learning to write, which requires on its part very considerable effort. In order to deftly guide the hand, and to prevent the pen straggling into devious lines, the shoulder girdle must be fixed, and this cannot be done unless the spine be to a great extent immobilized. A short spell at such work on a suitable table or desk is harmless, but when the mere pot-hook and round-hand period is past, when themes and exercises, as in the modern system of teaching, occupy some hours not only in the school itself, but also later in the day at home, the conditions under which the work is done and the attitude assumed in doing it become matters of great importance.* A fidgety child, constantly changing his position at the task, may probably do as little good at his writing as

* It may be assumed that defective vision necessitating excessive stooping will have been detected and properly attended to.

harm to his spine; but the steady scholar, anxious to do his very best, and sticking rigidly to his work, often maintains throughout the same attitude, which may happen to be injurious. It would be difficult to write, and still more difficult to read, a description of the many faulty postures, assumed by different children, but certain ones must be specified, especially as they are the bases or key to all, or almost all the others. The outline diagrams were rapidly sketched from patients, whose writing

FIG. 17.—CHILD WRITING.

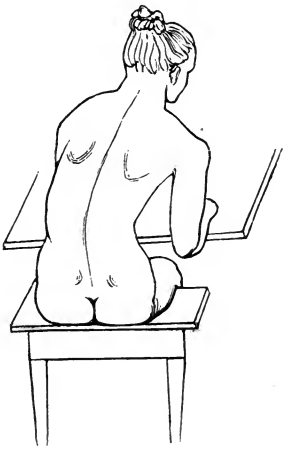


FIG. 18.—CHILD WRITING.

postures I had remarked; the former represents a child writing in his usual attitude, and at a flat table, as was customary. He is so bent to the right as to bring his head a little beyond the employed hand, while he watches the pen from the little finger side. Other learners practise a contrary trick, looking under the hand from the thumb side. These postures involve a twist or a sideways tilting of the pelvis, or both, the former resulting in version, the latter in amesiality. That is to say, the faulty attitudes,

assumed primarily in sitting, become in a little time so habitual as to influence also erect postures.

Detection of these faults by practised vision is not difficult. The sense, especially if unaccustomed, may however be supplemented by endeavouring to pass the hand flatwise between the stool and the child's tuber ischii. This, if there be a sideways slant, is quite easy on the one side, barely possible on the other. A backward twist to right or left can be verified by placing horizontally a straight-edge across the glutei (p. 23), and observing if one of its ends slope backwards; also, the knees may be utilized as indices of version by feeling under the table whether the one lay on a plane behind the other. Certain other attitudes may here be considered. No child should be permitted to study with one knee crossed over the other, because to do so necessitates pelvic version, for when the right limb is thrown over the left (or *vice versâ*) the calf of the former is on a level with the knee-cap of the latter, which can only be effected by throwing the right side of the pelvis forward. Another forbidden trick is curling one foot round the leg of the chair, such posture throwing that side of the pelvis back. There is, however, an attitude which has often been much condemned, though it is quite harmless—viz., crossing the feet, or rather the ankles. This position affects neither spine nor pelvis, and the child is quite sufficiently irked by admonitions concerning injurious attitudes without adding to its worry by prohibiting innocent ones.

Long and careful experience has taught me, although the subject is incapable of rigid proof, that the malpostures above described are the starting-point of amesiality and version.* For, as months glide by, the child-student becomes more and more inured to the hurtful posture,

* Most lateral curvatures are, as already shown, due to these positional defects.

assumed at first only in sitting, but soon dominating all his attitudes, because the ligaments and muscles adapt themselves to the bend or twist, so that correct station imparts a sense of exertion and of strain. Rather quickly, then, the sense of bodily rectitude is not merely lost: it is actually so perverted that what feels to him straight is awry; the pelvis and spine corrected by the surgeon's hand seem to the patient crooked. When muscular sense has fully accepted, as it very quickly does, this fallacy, the patient, however docile, trying to be straight, increases, by dint of his efforts, the deformation. The two errors—contracturing fibrous structures and cerebro-muscular perversion—abetting each other's injurious development, unaided by supervision and a directing guide the patient often by his efforts augments the evil.

In order to obviate or correct injurious pelvic positions assumed in writing, American and German surgeons have devised many sorts of desks and chairs, most of which are much too coercive. Many stools are provided with an upright back, to which the child is bound; some have, in addition, a cross-piece for fastening, by means of straps, the shoulders, while the waist is secured by the same means to the upright, and the feet, moreover, are fixed in sockets screwed to the floor. All these contrivances are far too stringent. No person, especially no young person, save in complete recumbent repose, can tolerate an unchanged position for any lengthened period. That which muscles more especially resent is a demand for even a slightly prolonged exertion at one unvarying length; they, by inflicting a cramp-like discomfort, insist on change. This is the cause of 'stretching,' indulged in by all warm-blooded animals after, as in sleep, having long been still.* Thus to place a juvenile on a chair, and to strap the trunk move-

* The muscles of cold-blooded animals are not thus sensitive; they are able to remain contracted at the same length indefinitely.

less to an upright or a cross produces a fatigue and a muscular resentment, that rapidly becomes insupportable, and the pupil instinctively seeks relief by twisting his spine and pelvis, with their fibrous covering, into some new, faulty attitude. There is plenty of room for such; the straps can but hold the more outward part of the body still; within the surrounding fleshy parts the bones have a considerable amount of play, as everyone who has tried to hold even a little baby still must know.

The child must be allowed, within well-defined limits, a certain freedom, and in most cases it suffices to so arrange the relative height of chair and table that the edge of the latter is on a level with the sitter's xiphoid cartilage. On the table is to be a desk, with an angle of about 30 degrees, and this should be provided with a ledge about as thick as a cedar pencil, but one side flattened, in which two pegs are fixed that fit into holes at the edge of the desk, so that it may be shifted to different heights, the pupil not being allowed to write at the lower edge of the desk. A watchful eye should several times in the morning verify correct posture, according to the suggestions given above (p. 30). When a bad habit has been recently acquired, this amount of care will in a week or two correct the evil, unless the child be recalcitrant and obstinate. Where those psychical defects exist, also in cases where a bad pelvic attitude has already begun to affect the spine, some external agency may with advantage be used. Thus, if the error be that shown in Fig. 18, where the body-weight is thrown on the right buttock, a hollow wedge of wood (see p. 57) should be provided. The distance between the two boards at one end should only be 1 or 1½ inches, and this end is to be on the child's left. Between these boards at the thinner end a bandage, the central part of which consists of elastic webbing, is passed, and, the child being seated, is wound round the top of the thigh, the front lap

crosses the hind one outside the hip, where they may be tied with a single knot (called technically 'overhaul'). The rest of the bandage runs round the pelvis, and meeting again the front lap is secured at the right hip. The elastic part need not be longer than from 4 to 6 inches, and must lie on the inside and front of the thigh. Of course, if the pupil be feminine the arrangement must be under the skirts; in such young subjects the fiercest prudery could hardly object; a rather thin cushion may be laid on the seat.

For the backward twist of one side of the pelvis the back of the child's chair should not be more than from 4 to 6 inches high, and he is to sit with the back of the pelvis against it. The intention is that it should be a guide both for the docile pupil and also for teacher or nurse, who should every now and again glance at the position.

If any case seem severe enough to warrant the use of an external force, such should never be of a rigid nature, such as leather belts or iron hoops. Coercion of this sort fails to effect the object, where the tireless persuasion of elasticity will succeed.

CHAPTER IV

CERTAIN PREVALENT METHODS

PREVIOUS chapters have shown, that save in a small number of cases lateral curvature is the direct result of certain postures of the pelvis; hence it is evident, that to cure the effect, the cause must be eliminated. We must indeed go further; the defect at the pelvis necessitates a compensating deviation of the spine, which is at first merely positional—that is to say, for a certain period any temporary correction of the former rectifies the latter. But this period is not long protracted, and if the bad pelvic habit continue, the muscles, ligaments and other fibrous structures adapt and harden themselves into the vicious posture; and the longer it is allowed to continue, the more inveterate, the more recalcitrant to remedy does the malformity become. Thus, in the very earliest manifestation of a curvature it is very important to waste no time on futilities, nor even on such gymnastics as may improve general health and muscular tenacity, but are without direct influence on parts involved in or producing the defect—*e.g.*, 'lying on back, arms by the side of the body, hands supinated, slow, full inspiration by the nose, slow expiration by the mouth (repeated four times),' etc.; standing, with 'the right arm directed upwards, the left outwards at right angles to the body.' We will, however, leave these, and go on to consider gymnastics properly

so called. Someone with commencing or moderate curvature goes to a gymnasium, exercises the arms with a 'chest expander,' lies on the back, and lifts each lower limb with straight knees alternately to the vertical, stoops and touches the toes, hangs by the hand on a horizontal bar, etc., etc. These exercises will in due course strengthen the muscles, among them those on both sides of the spine. But as scoliosis is a unilateral defect, as one side is stronger than the other, nothing is gained by adding equally to the power of both. But more than this: it frequently happens that exercise is directed to the wrong, to the stronger side. This is in part due to the shortening of muscle in the concavity of the curve, and in part to misinterpretation of a certain appearance. It was in the first chapter explained that, owing to rotation, the transverse processes on the convex side push back the superjacent soft parts (p. 10), and cause a prominence that may be—indeed, often is—mistaken for strong muscular action. Very little consideration however shows that, whether we have to do with a limb or the trunk, the acting muscle must subtend the entering angle or curve. Thus, in a left lumbar curve that muscle which skirts the convexity and gives the deceptive appearance of strength is in reality the weak and inactive one, to which invigorating exercises must be directed. In this light let the result of suspension be considered, while it is remembered that, unless full anæsthesia be used, traction in the direction of its fibres always causes a muscle to contract. But as in left lumbar curvature the right erector spinæ is shorter than the left, suspension causes the weight of lower limbs, buttocks, and pelvis to drag on—that is to say, to exercise the very muscle, which already is too strong, and which by its induced contraction protects the ligaments in the concavity against the tractile force. An appearance of improvement during suspension is fallacious, being caused by tightening of the integument,

the subcutaneous fasciæ and fat of the loin. These parts, being necessarily looser on the concave side, are more obviously affected by the potent elevation of arm and shoulder than are those on the convexity, even to such degree as to influence measurement by a lead wire. My frequent employment of this method before, during and after suspension has in some cases shown me this deceptive change, but I never found that a patient a few minutes after being let down was the least straighter, even after long suspension. Certain cases were, I am sure, a little worse, presumably because contraction of the right erector was prolonged up to or beyond the time of measurement.

Experience as to the inefficacy of this procedure led to the adoption of another device—namely, suspension on an oblique bar or on two bars, the one a few inches above the other. Of this method it is alleged that 'the curvature to the right is effaced by the left hand being placed higher than the right.'* The photograph reproduced on the same page goes far to refute this averment. I have taken many photos of patients thus crookedly hung; not one of them shows any sign whatever of improvement. Moreover, the imagined effect, whatever it may be, is merely momentary, or, as the above writer says, 'is difficult to maintain'; in other words, the useless exercise is a detrimental loss of time.

Something must also be said concerning potent machinery for straightening crooked spines in recumbency. Complexity and multiplicity of implements for carrying out a fairly simple mechanical object constitute a clear test as to the unfitness of the expedient for obtaining the end in view. I have collected from various writers no less than twenty-three mechanical couches for stretching curved spines. These are provided with belts or straps to encircle head, shoulders, pelvis, and lower limbs; to these

* 'On Deformities,' A. H. Tubby, p. 174.

are attached either weights playing over pullies, levers, and ratchet-wheels, strongly reminiscent of Torquemada. And yet the error is very patent, for there can hardly be many people in the world who, wishing to straighten a bent staff, would try to do so by pulling at both ends.

In regard to gymnastics a goodly number of fallacies exist. In thus writing, it is not intended to imply that they are all useless; but that it is necessary to discriminate what they can, from what they cannot do. The sort mentioned at the beginning of this chapter—viz., such as exercise about equally right and left limbs and both sides of the body—belong to preventive rather than to remedial measures—that is to say, a juvenile afflicted with such bodily weakness, as to threaten lateral curvature may escape by strengthening the whole muscular system. One, who has already acquired a curvature, must have the exercises specialized, must omit such as employ the stronger group, and especially practise such as strengthen its fellow of the opposite side. Flaccid and elongated muscles must be made tense, and shortened ones strengthened. Also, such exercises and positions as correct whichever of the pelvic malpostures may be present must be sedulously practised.

Connected with this subject of strengthening weakened spinal muscles must be mentioned treatment by prolonged recumbency, which was much in vogue beyond the middle of the last century, and, unfortunately, has not as yet quite entered into nirvana. An almost miraculous power was attributed to these things; many girls not only healthy, but also perfectly straight, were condemned to lie on them for some hours daily; no schoolroom was considered complete unless provided with 'an inclined plane or couch,' it being erroneously supposed that the slight slope might, through the medium of pelvis and lower limb weight, exert some tractile power on the spine. Girls, however, who did

show signs of crookedness did not escape so easily. Many such have been kept bedridden, and on a hard bed too, for several years, with such effect on vitality and health as may be readily imagined; but without benefit to the spine.

Reproduced here are two photographs of mechanisms (Figs. 19 and 20) called spinal supports; they are made

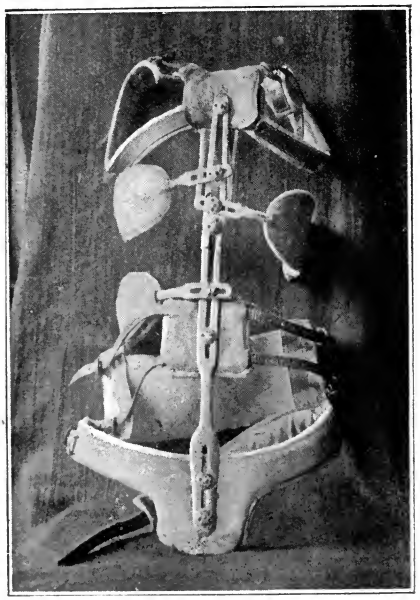


FIG. 19.

of steel, covered with leather or other material. The objects they are intended to attain are two: Firstly, by means of pads on branches, to press protuberant or deviated parts nearer to the middle line; secondly, to transfer the weight of the head, shoulders and chest from the spinal column to the pelvis, to what is called 'take the weight off.' Until 1868, when the first edition of my work on lateral

curvature appeared, such machines, together, in many instances with recumbency, were almost the sole methods of treatment, consecrated by long use, although it is very easy to see that they cannot fulfil the tasks entrusted to them. As to the pressure on undue prominences, a glance

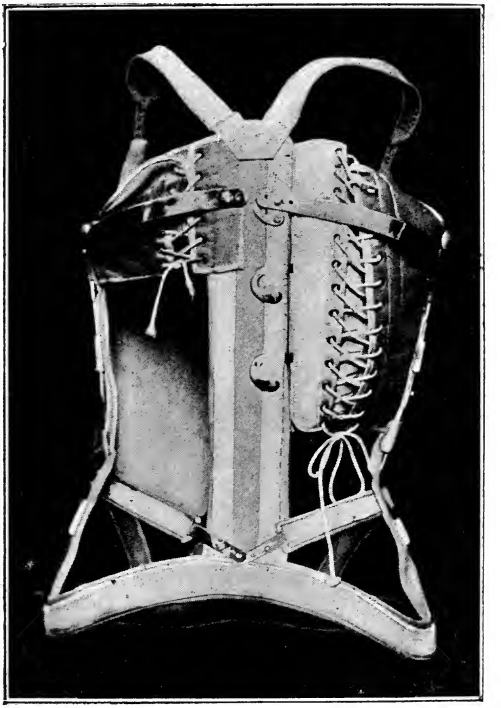


FIG. 20.

at the figures shows that this is supposed to be exerted by pads attached to more or less horizontal arms (Fig. 19), or by coutil half-corsets (Fig. 20). Whichever of these is adopted, each of them takes its bearings from rods projecting vertically from a metal belt encircling the pelvis,

and therefore the stability of the uprights is entirely dependent on immobility of the pelvic belt. It is, however, impossible to procure any degree of such fixity as to confer upon those pressure-pads or corset arrangements any power. Indeed, if the pelvic girth were tightened beyond the limits of the bearable, even then the skin and other soft parts move, especially in the female, over the subjacent bones with more than sufficient freedom to allow entire instability to the belt and its superstructure. A great many people have come to me carrying on their bodies these things. I could in every instance, by moving without any force the uprights from side to side, cause the girdle to sway up and down on the pelvis, or by grasping the girdle make the vertical rods and pads waggle to right and left.

Still more inept is the idea of 'taking the weight off.' Attention may now be directed to the crutch-handles (Fig. 19) and to the half-hoops (Fig. 20), intended to lie under the armpit, and by upholding the weight of the shoulders transfer it to the pelvic girdle. But in order to effect this object the patient's trunk, shoulders, etc., must be kept perfectly rigid. Any movement—stooping, or turning the upper on the lower half of the figure—must either be rendered impossible or the shoulders inevitably escape from the implement, and are no longer upheld; in fact, they can only be supported by being raised on the crutch-handles. The patient has the choice of either going about with the shoulders about her ears and with her figure entirely stiff, like a badly-carved wooden doll, or of slipping them out of the crutch. In the latter case, which is what patients prefer, the thing becomes merely extra weight to be carried about. Moreover, the chief burden on the spine—the head—is entirely left out of count. Another fault also rendering these inventions useless, coinciding as it does with errors of other appliances, will be mentioned in the sequel.

My testimony, however, as to the inefficacy of these

contrivances may possibly be considered vitiated by the fact that I have never used but one, that experience being more than enough. Therefore I will quote the opinions of some who, as far as I know, did not employ any other measures.* 'They are not adapted to the removal of the primary cause of lateral curvature; they cannot, therefore, be employed as curative means.'† 'I have no hesitation in expressing my conviction that if these cases be subjected to treatment before any obvious external deformity has occurred, they are generally curable in within one or two years. In some instances, especially if a hereditary tendency to spinal curvature exists, and the girl be of feeble constitutional power, a longer period may be required.'‡ 'When rotation has taken place these appliances are useless.' 'The result of my experience is to convince me that where lateral curvature existed in any marked degree, and before it amounted to an external deformity, it is an essentially incurable affection.'§ All these phrases, be it borne in mind, have only reference to treatment by spinal supports The last two quotations show the advocates of these misappliances to say that if a strong young girl of healthy parentage be incarcerated in one of these things she may perhaps in two years be cured of a deformity which in reality does not exist, for the term is surely inapplicable to a condition which is imperceptible.

The poroplastic jacket has that defect which was referred to a few paragraphs ago as one of the many inherent in 'spinal supports.' If the reader will refer back to

* This statement does not apply to the later periods of their practice; after the year 1868 some of these gentlemen used jackets of poroplastic felt and of plaister of Paris.

† Little, 'On Deformities of the Human Spine,' p. 370.

‡ Adams' 'Lectures on Curvature of the Spine,' p. 327, first edition.

§ Brodhurst and Adams at Medical Chirurgical Society, *Lancet*, January 23, 1886.

the two photos on pp. 38, 39, and more especially to Fig. 20, he will perceive that the right and left side-rods are bent in different degrees, in order to fit the bodily malformity, otherwise the rods and irons would bulge beneath the garments like scaffold-poles and buttresses. But it passes the wit of man to say how a human figure put into a crooked splint can come out straighter than it went in. The felt jacket is also moulded on a distortion, which therefore it is perfectly adapted to maintain ; the suspension during which the jacket is moulded confers only a fallacious appearance of rectification. Plaister of Paris jackets labour under the same charge, being moulded on a crooked figure, which is kept for weeks or months in the distorted case. This last splintage has, moreover, another serious defect : it greatly interferes with respiration, and the patient, encaged for years or even for months in such appliance, nearly always comes out of it with narrowed and flattened chest, very immobile ribs and shallow, inefficient breathing.

CHAPTER V

DEVIATION AND ROTATION

So important a portion of the body as the spine cannot suffer derangement without involving neighbouring parts, and, if the deformation become severe, without disturbance of several vital functions. In a volume, so small as this is intended to be, it manifestly is impossible to describe all these perturbations ; suffice it to say, that owing to the gradual production of the malformity, they are much less severe than the changes in the form of cavities might lead us to anticipate. The most noticeable effects are embarrassment of breathing and of heart action, yet even these are but slight during quiescence, only becoming marked when some exertion is considerable or prolonged. Still the capacity of the chest is on the right (convex) side greatly diminished, partly by the sharp bend of the ribs, chiefly by intrusion into it of the rotated vertebræ* (see Fig. 40 in Appendix VII.) Also very evident is the wide separation of the ribs on the same side, whereby, at the mid-axillary line, the intercostal spaces are unduly broad, and the length of the thorax on that side very much increased. The tenth rib often lies within the arc of the crista ilii. On

* In the College of Surgeons' Museum is a scoliotic skeleton (Pathol. Series, No. 2099) in which the distance from the anterior (now almost lateral) faces of the fifth and eighth vertebral centra to the bodies of the opposite ribs averages $\frac{3}{8}$ inch.

the left of the concavity the ribs are abnormally straight, their sweep wide—hence that half of the chest is broad ; but they are along the axillary line too close together, the intercostal spaces too narrow, and that side of the chest abnormally short (see Fig. 40 in Appendix VII.). On both sides the intercostal muscles are thrown out of gear ; the thoracic framework is very immobile.

The backward protrusion of the ribs is due to rotation ; the alterations in their relations to one another to deviation. That this is so is easily demonstrable on a severely deformed figure, as in that depicted in Fig. 6, as also in the scoliotic skeleton ; but to him who has learned how to look for these two constituents of lateral curvature (see p. 8), early and slight cases will reveal the predominant tendency to one or the other element of the deformity. All surgeons having much opportunity of studying cases of curvature must have noted in any given series, that even though the evil affect the same vertebræ and be in the same direction, yet the shapes of the figures differ considerably, in consequence of varying ratios between the two constituents of curvature—deviation and rotation. This is not a mere academic distinction, for as will be shown in a future chapter, treatment, to be of the most effective sort, must be primarily and chiefly directed against the more cogent of the two evils. The methods of appraising the influence of each might be deduced from Chapter I. Nevertheless, though what follows may seem but recapitulation, it is better to describe succinctly the signs of each malforming agency. As already said, rotation expresses itself on the surface of the back, lateral deviation on the side outline. The first example may be the most usual form of lumbo-dorsal curvature—*i.e.*, the lower curve to the left, the upper to the right.* In such cases there is on the right side out-

* This is mathematically an improper mode of description ; in that science the whole S forms one curve : the place where the direction

line, traced from axilla to waist, a convex sweep, which, as it approaches that latter level, trends somewhat rapidly inward—*i.e.*, towards the mid-line of the body. At that level the margin of the figure starts somewhat abruptly outward, so that these two outlines (thoracic and pelvic) form between them a well-marked angle, which gives to the hip-bone of that side a fallacious appearance of prominence. On the left the outline is concave from top to bottom, its curve being like the hollow side of the crescent moon. When these characteristics are well marked, while the surface of the back is comparatively little changed, while the great protrusion backward of the ribs obtains, while the triangular depression just above the right iliac crest (see Fig. 5) is absent, or is, at all events, not a marked feature, and while a hard, almost sausage-shaped convexity running up along the left side of the lumbar spinous processes is not much in evidence—in all such cases lateral deviation is the dominant factor of the evil. The contrary conditions — that is, accentuation of surface changes, combined with slighter abnormal form on the margins of the figure—testify to the opposite relationship.

To note the conditions in various forms of curvature. A lumbar curve unaccompanied as yet by dorsal change exhibits, when lateral deviation is the prevailing element, a deep incavation of the right side outline at the waist, with little bulging, and with slight hardening of parts on the left (convexity) of the spinous processes. It is true that by pressing in this locality with the finger-tips difference in the resistance on right and left side may be detected even in very early cases ; but it is sufficiently occult to need scrutiny, and is far from being commensurate with

changes is " the point of inflexion.' But in surgery the deformation has always been described as consisting of two curves, and it would be unwise to attempt a change in nomenclature consecrated by long use.

the asymmetry of the side outline. In the contrary condition, *i.e.*, when rotation is the dominant factor of the curve, prominence and hardness along the left of the spinous processes are more conspicuous features than alterations at the margins of the figure. Especially noteworthy is the triangular depression shown in Fig. 5, running from the exaggerated incavation of the waist inward towards the spine. In the example referred to this is unusually emphasized, but if carefully sought while letting the light fall on the figure from different directions, it will be found in all cases of lumbar curve in which rotation is the principal element.

Total simple curvature to the left is distinguished by the signs of lumbo-dorsal curves as described in the first chapter. It was there stated that the signs of an **S** curve appear in the upper and lower halves of the figure to right and left alternately. In the total curve they do not so interchange their positions. The bulging backward of the posterior chest-wall and of the erector spinæ at the loin are both on the same side, as also is the hollowness or flatness of the other lateral half of the figure. On the right the concave, on the left the convex, form of the side outlines follow or mock each other from axilla to hip (see Fig. 3). Whether in such cases deviation or rotation preponderate must be estimated by comparing the amount of aberration in form of margin and of surface.

In judging the amount of rotation in any given case, the surgeon should not be content with merely looking at the surface from behind with light falling direct on the figure, but should also avail himself of the method described at p. 11, depicted in Fig. 7. So, with some experience in spinal cases and some care in the appreciation of form, he will be able to arrive at a very reliable judgment as to which was the prime factor in the production of the malformation.

In the text (p. 2) was, and in Appendix V. will be, shown that a close and intimate association exists between sideways bending and rotation of the spine; but these factors, though in point of time they may be synchronous, yet they are not concurrent in point of etiology. The early age at and the unnoticed manner in which the malformity begins throw obstacles in the way of clearly demonstrating which is the pristine factor, yet the following, which is the outcome of considerable study, may be offered to the reader, not as a definitive, but rather as a tentative explanation of the different origins of scoliosis. Certain curves of the dorsal region were at p. 25 described as 'weight-bearing and avocation curves.' Others in the same part of the figure were shown to be due to respiratory troubles, and there are doubtless a few other origins of the evil. The far larger number of **S** curves begin at the loin; the defect there is in some instances immediately, even simultaneously, productive of dorsal curve in the opposite direction, yet in the majority of cases that sequela is of slower advent, in the following manner: The lumbar curvature, by encroaching on higher parts of the column, becomes total, and this, when such a degree is reached as to contravene the laws of balance (see Appendix VIII.), transforms itself of necessity into the **S** form.

Lumbar curvature is, in my opinion, always due to one of the three pelvic malpositions.* Obliquity and amesiality produce primarily lateral deviation; version causes rotation.

* Or to two, amesiality and version being the most common combination.

CHAPTER VI

TREATMENT OF PELVIC DEVIATIONS

WHEN the surgeon examining a scoliotic patient has verified a deviated pelvis, whereon the spinal malformity depends, his most pressing aim will be to correct the faulty posture in the former part of the body, and, of course, he must be guided as to choice of remedial measures by the particular posture he has detected.

Permanent pelvic obliquity, when due to uneven growth of the limbs, cannot by surgery be corrected. The evil effect on the spine may, however, be prevented by means that will find more appropriate place in the next chapter. If the inequality be due to precedent joint disease, resulting in angular anchylosis, a surgical operation of slight severity may in many cases restore pelvic horizontality.

Habitual pelvic obliquity is sometimes due to unilateral ovarialgia, which must be treated by experts in that class of diseases ; but in the large majority of such cases the wrong position is a mere trick or habit (p. 16), which must, of course, be discontinued, and also for a certain part of each day reversed. The surgeon is in a large degree dependent on the patient's docility and goodwill. Unfortunately, such mental condition is not always present. Some girls resent adverse criticism of their attitudes, and some greatly dislike their mother's admonitions ; indeed, if such are frequently repeated, mayhap with some

acerbity, recalcitrance is often engendered, even to the point of doing, when unobserved, the very reverse of that which they are 'everlastingly bothered about.' Such restiveness inevitably brings about its own regrettable reward.

Pelvic amesiality is a condition of which the patient is quite unaware until it is pointed out, which I usually do by means of such photographs as are reproduced in this book. Indeed, such patients believe that they stand straight, and when by the surgeon's hand the pelvis is gently moved into the right position, they say that they feel very much awry. Under those circumstances the pelvis should be for a time held straight, and the patient must study the feeling produced ; afterwards she is several times a day to assume the drill posture, endeavouring to make it such as produces the sensation experienced while the pelvis was pressed into the right position. Occasionally the mental topsy-turveydom of straight and crooked corrects itself somewhat rapidly. If, however, such change be protracted, other devices must be added. When in her own room and undressed, she should stand opposite a cheval-glass and hold the unweighted end of a plumb-line with both indices on the middle of the manubrium sterni, and so arrange her figure that the string passes over the xiphoid cartilage,* the umbilicus, and other medium parts, including the knees and ankle bones, between which last the lead should hang. Arranging thus her figure, the patient is to study the resultant sensation, and in the ordinary daily duties should, standing in drill posture, reproduce it. The surgeon must not, however, rest content with a verbal report of feelings haply supposititious, but should, at not too distant intervals, verify the condition.

* As this part is not distinguished by any external markings, it is advisable that the surgeon should make a dot there with tincture of iodine.

For this purpose there should be in the consulting-room a plumb-line dependent from the ceiling or elsewhere. Undressing below the hips is not needed, the skirts being so arranged as to show the heels (Fig. 1). The surgeon directs her to stand a foot or more from the string, and so places himself that it coincides in the line of sight with the interval between the heels, and notes whether it also corresponds in that line with the top of the intergluteal fissure and with other median parts of the figure ; if not, she must be requested to correct her attitude. If unable, the surgeon must manually adjust her figure, and refer her to her studies of correct station.

Another method is less dependent on the patient's goodwill. The ' lateral sling ' consists of a board (14 × 6 inches)

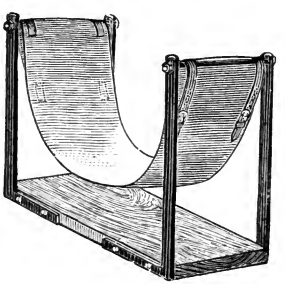


FIG. 21.—THE LATERAL SLING.

and two pair of angle brackets ; between each pair is a bolt, to which a 6-inch wide webbing is sewn. This being placed on a sufficiently resisting couch, the patient lies on it with the amesial hip supported by the webbing loop.* The posture is comfortable ; the patient may pass on it a considerable time reading or sleeping. Lying on the right side upon a sofa that has no arm at one end, and so that the edge corresponds with the crest of the ilium, the patient

* The sling is in Fig. 32 depicted as used for dorsal curvature—*i.e.*, at the shoulder ; for amesial pelvis it must be at the hip.

props the projecting trunk by his right hand on the floor, the left shoulder being on a level, scarcely or not at all higher than the pelvis; or if no such sofa be available, the same can be done across a bed. If feeble patients find they cannot continue this sufficiently long, much of the fatigue can be obviated by allowing the head to rest on the seat (pillowed) of a chair.

Both these postural correctives are performed in recumbency—*i.e.*, while muscles are inert—but a like measure should be used while those organs are in action—in the erect posture. With this object I devised 'the wall exercise,' shown in Fig. 23; nudity, however, delineated merely

FIG. 22.—THE SIDE POSTURE; THE COUCH IS RATHER TOO LOW.

for the sake of clearness, is unnecessary. Right amesiality being postulated, the patient stands with that side against the wall, taking care that the figure is at right angles to it; the right foot (heel and toe) is placed against the wall, between which and the patient's pelvis a block about 2 inches thick, $3\frac{1}{3}$ wide, and not less than 5 long, is placed edgewise. A companion or maid gently upholds the

figure, with the hand just below the axilla,* and the patient puts the left foot (heel and toe) against the right, and thus stands till the advent of slight fatigue. At first about

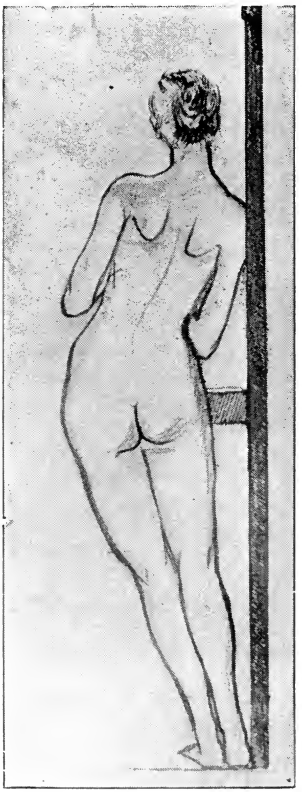


FIG. 23.—THE WALL EXERCISE.

three minutes suffice ; after some practice more can be borne ; this is partly due to custom, and in part to improve-

* The place is marked by a cross in the diagram. The side of the block next the patient should be rounded to avoid pressure by a sharp edge.

ment in pelvic posture, whereby the exercise becomes much less strongly opposed to the usual attitude. The breadth of the block, as above given, need not be regarded as an unalterable law. Children and short persons should be provided with a narrower, tall and willowy figures with a broader one. Attention may be drawn to the fact that this remedial posture places a pelvis habitually amesial to the right about $3\frac{1}{3}$ inches to the left of the line of gravity, and at the same time counteracts lateral deviation of the lumbar spine, while it confers on the muscles tendency, and after a certain time ability both to correct the pelvic fault and to rectify the curve.

Pelvic version requires for its correction some goodwill on the part of the patient, but given that disposition, the cure is, as a rule, somewhat rapid; it is neither painful nor tiresome. The essential is that the faulty habit be not only discontinued, but that also the contrary should be for a time substituted. The wry posture obtains, be it remembered, in the sitting, as well as in the erect figure (p. 25), and in the former one knee, that on the side which gives its name to the bad attitude, lies behind the other. The wrong position, by means of the straight-edge and its obliquity when laid on the *ligamenta patellæ*, may be explained to the patient, who should then be told to advance the back-lying knee, till it projects a little more forward than the other. Care must be taken that in this manœuvre the whole figure is not twisted. This can be tested by insisting before and after the knees are regulated that the patient sit so far on to the chair that the shoulders are supported and kept in order by its back. The sensation produced by the rectified or even over-rectified position should be noted. Moreover, the patient must be told to procure a straight-edge, such as a long flat schoolroom ruler, and when seating herself to some occupation, or to repose, to test the posture by placing it athwart the knees.

Also, the method of standing should be corrected by the surgeon's hand, and the resulting sensation studied. For better correction of version in the erect position a somewhat more potent method may be used, especially if the condition be strongly marked. The object is to turn the pelvis into or a little beyond the right position, and this without any twist in the same direction of chest and shoulders; in order to insure this latter postulate the upper arms are to be used as stays or stanchions in the following manner: Both heels are to be placed against a vacant wall, both shoulder-blades equally in contact with it; but their dimensions are too narrow to give certainty of correct position. Therefore the patient is to place the palms equally on the top of the chest, the finger-tips as near together as may be, while the back of the arms, held at right angles to the body, touch the wall on each side. The surgeon then shows whomsoever will in future assist, how to move the verted side of the pelvis forward, and to place between it and the wall a book, block, or firm pad of such thickness as can be borne, and is as much as possible commensurate with the degree of abnormity—that is to say, approximately, between 1 and 3 inches.

Children with verted pelvis still occupied with writing tasks must be carefully watched; the teacher or governess testing the position should not be content with mere ocular appearances, but, occasionally passing the hand, should feel if the knees be placed evenly; or, with a straight-edge applied to the back of the pelvis (p. 32), should look for and correct version; or, by investigating whether the child sits so as to throw the weight only on one ischium, forestall amesiality.

CHAPTER VII

TREATMENT OF LUMBAR CURVES

THE motive of Chapter V. is to insist on the two constituents of lateral curvature, and to elucidate the signs by which the primary may be distinguished from the resultant one, and therefore, in regard to treatment, the less imperative one. In very advanced cases this distinction is of less value than in more recent and slighter though increasing curvatures, for these should at once be subjected to methods aimed at annulling the principal deformation. For that reason the procedures about to be explained are divided into two chief categories—viz., those directed against lateral deviation and those combating rotation. Each of these, moreover, falls into two parts—those which enjoin a posture contrary to the morbid one, and those which exercise the muscles that amend, as they get stronger, the faulty conditions. Thus, both the remedial measures consist of positions and of exercises ; certain of them, indeed, partake of both characters.

The deformation inflicted on the spine by pelvic obliquity is primarily lateral deviation, and is at first confined to the loin. In a certain number of cases limbs may be equalized by straightening a bent knee or hip, sometimes by rectifying an equinous or valgous foot. If these and similar means are inapplicable, we are reduced to supplying a succedaneum for the deficiency in length. Figs. 18 and 19

show that the spine, crooked during obliquity, becomes straight by levelling the pelvis, provided the curvatures have not been allowed to become persistent—that is, to have been reinforced by contractures and tie rods (Appendix VI.). In regard to obliquity from unequal limb growth, it must be stated, that when that function slackens previous to cessation, the two limbs frequently become more, and may even become quite, even, the limb which grew quickest ceasing to grow first. Thus it is highly important that obliquity, while it lasts, should be debarred from inflicting on the spine a persistent curvature, in consequence of which provision it often is possible, after the age of twenty to twenty-four, or earlier, to discontinue the measures about to be described.

As substitute for the deficient limb length, a shoe having a heightened sole must be worn, which, unless the inequality be excessive (a rare condition save in paralysis), need entail no limp nor unsightliness of footgear. Should wooden heels be worn, one can be made rather higher than the other ; if the heels be of leather, one layer whereof such are built, can be omitted on the long-limbed and one added to the short-limbed side. Such arrangement is imperceptible to the surrounding society. If the patient be still in a rapidly-growing age, it is desirable that the foot with heightened heel should be manually stretched (in dorso-extension) night and morning, or, indeed, whenever the boots are changed.

To consider pelvic obliquity from joint disease trenches on a very wide subject, which here can only be indicated. A knee bent at an angle may often be straightened by manual force, with perhaps tenotomy, if anchylosis be false ; if true, osteotomy proves, in well-selected cases, of the greatest advantage. Hip-disease may leave very regrettable deformations, sometimes from anchylosis or dislocation, often merely from contracture of flexors, and

especially of adductors. In these last conditions, in carefully diagnosed cases, very much may be effected by surgical arts.* Many cases do not admit of such methods, and the irremediable deficiency in length must be compensated by a shoe, sometimes considerably heightened. Although nowadays these appliances are much less cumbersome and unsightly than formerly, yet they should only be ordered when absolutely necessary.

The correction of obliquity is not to be limited to the erect posture, for it may also be used on seated patients by means of a sloping seat,† which consists of two boards (15 × 11 inches) bevelled and screwed together at one end, held apart at the other by a cross-piece from 1 to 2 inches high.

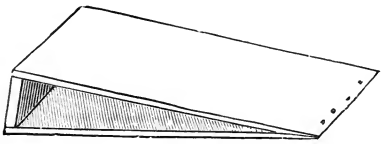


FIG. 24.—THE SLOPING SEAT.

This is placed on a chair, and the patient sits on it, with the high end under that side of the pelvis which droops, for at least twenty minutes three or four times a day. Indeed, the slighter degree of slope may be used constantly; to such patient should be assigned a chair on which the wedge may always be kept, masking its peculiarity by a covering of cotton velvet or other fabric; or, better still, from a specially allotted chair may be cut off the legs (back

* See the present writer's treatise on 'Diseases of the Joints.'

† This device was invented by me forty-four years ago, and published in my first edition on 'Lateral Curvature' in 1864. Seven years later Professor Volkmann borrowed not only the idea, but also my illustration. English orthopædists refer to it as Volkmann's; it is true he made an addition, which, however, is by no means an improvement.

and front) of one side a certain length. The proper amount of slope in all these devices must be prescribed by the surgeon. In my practice I test the angular degree by means of a stool, one side of which can be raised when the patient is seated on it by cog-wheel and ratchet. To give a patient a sloping seat hinged like Volkmann's, allowing

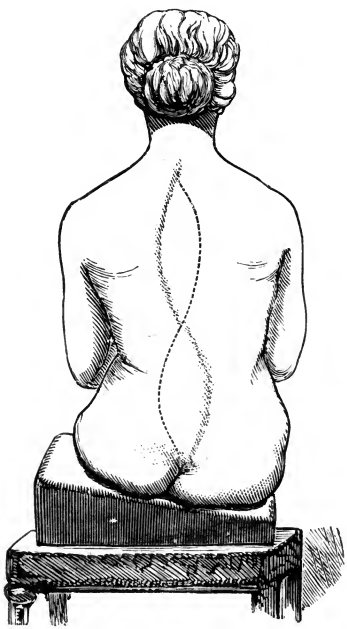


FIG. 25.—SLOPING SEAT IN USE.

variation of slope according to whim and fancy, is an error in judgment.

Another device is the lateral sling. It was mentioned and depicted at p. 50 as one mode of dealing with amesial pelvis. In using it for that purpose the patient lies with the deviated side of that bone on the webbing loop. As a

remedy for lumbar curve (left) the patient is to lie in such wise upon it that the woollen material just skirts by its lower edge the crest of the ilium. The deformation also includes a certain degree of rotation ; the decubitus should not be quite on the side, but turned a little on the back.* These measures are employed while the patient—*i.e.*, the muscles—are in repose. They may be aptly named 'postional remedies,' and when dealing with patients, whose muscular or general condition is feeble, prudence counsels postponement of more exacting procedures until more vigour is manifest. A little consideration, however, shows that if the muscles, especially the erectores spinæ, be more potent on one side than on the other, their very action in maintaining the erect posture must result in also maintaining the curve ; therefore positions valuable in correcting faults of the passive bones cannot of and by themselves correct unequal muscular force. Thus it is necessary to supplement position by exercises so specialized as to fortify the weak muscles—that is, in the example now under consideration the erector spinæ on the left (convex) side of the loin. Fig. 22 at p. 51 represents a posture remedial of amesiality to the right ; it may serve to facilitate explanation of its use as a unilateral lumbar exercise. The patient, lying, as there depicted, at the end of a couch, or across a bed, lifts the supporting hand from the floor, maintaining the horizontal position of the trunk until fatigue in the left loin is felt ; the hand is then replaced on the carpet. This may be repeated three or four times, if so much can be borne ; but in this, as in every other specialized exercise, care must be taken not to weary the muscle too much. The exercise for those in whom it produces subsequent backache may be mitigated by a slight change in the posture, and this is desirable until the left muscle has become stronger. The patient lies on the

* At p. 71 the sling in use, but for dorsal curvature, is depicted.

front of the figure at the end of a couch ; to assume the position she first kneels about its middle, and when lying down so arranges a firm cushion or sand-bag ($2\frac{1}{2}$ or 3 inches thick) that it props the left iliac spine. For a few seconds both hands remain on the floor, till it be ascertained that the cushion really turns the pelvis a little on to its right side, then both hands are lifted until the back tires, replaced and lifted alternately.* In this posture the cushion, having rendered one side of the pelvis higher than the other, does not, as in the preceding exercise, throw the task

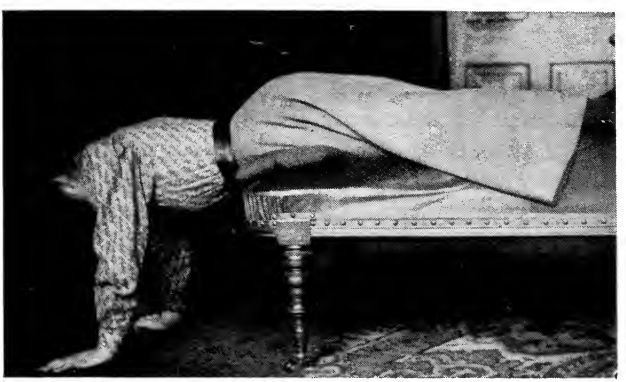


FIG. 26.—SLOPED HORIZONTAL EXERCISE.

of upholding the trunk solely and entirely on the left erector ; it entails, therefore, less exertion. A still milder mode of exercising the left erector spinæ has two advantages : it may be added to the above, or it may be solely practised several times daily without preparation or adjuvant. The patient stands in drill posture with the right side near to but not in contact with a piece of furniture, a shelf or mantelpiece ; placing on it a finger of the

* It is nearly always necessary that the legs should be held down by a small weight, such as a sand-bag, or by an assistant's hand.

right hand to maintain balance. She then, with all joints of the lower limbs quite straight, lifts the left side of the pelvis, together with thigh, leg, and foot, as high from the floor as she can, and maintains the position until some fatigue is produced, then continues to lift and replace the foot alternately about four times. Noteworthy is it that these exercises, while strengthening the muscles, also tend to, and after a certain period of work do really, annul or reverse the morbid curve. Other methods which I have used might also be mentioned, but these, as far as lateral deviation is concerned, suffice.

Passing to untwisting or 'aphelic' positions,* the patient in this instance lies on the left side, flexes the

FIG. 27.—FIRST APHELIC POSITION.

thighs to a right angle with the body's axis, and feels with

* The figures here shown were taken from a patient with right curve; in dealing with left cases the position and description must be reversed.

the right hand that neither knee lies further forward than the other. All the upper segment of the trunk is then so turned that this part of the body lies on the front of the chest; the head reposes on the right forearm; the left arm is thrown back and skirts the figure at the dorso-lateral aspect.

The second aphelic position, also here depicted, reverses the posture; the patient (right curvature) lies as

FIG. 28.—SECOND APHELIC POSITION.

to pelvis on the right side, and throws the upper half of the body over so that it lies on the back. In both the rectangular flexion of the thighs and attention to the equable position of the knees insures absence of any twist of the pelvis. Both these figures were photographed by a camera vertically above the patient's last dorsal vertebra. The postures are quite comfortable; the patient may—in fact, often does—sleep. There is, of course, no necessity for nudity; but in instituting and teaching the method

the surgeon should have the spine bared, and assure himself that the twist do not encroach higher than the ninth dorsal vertebra ; it does not often tend to do so.

To these positions are to be added aphelic exercises. For curvature to the left, purely lumbar, the patient is seated

FIG. 29.—APHELIC EXERCISE.

on a chair, the feet at some distance from each other, the knees asunder, which attitude prevents participation of the pelvis in the subsequent spinal movement ; she places the right forearm behind her, the back of the hand resting on a level with the eighth or ninth rib. She then turns all

the upper part of the body as far as possible to the right. So placing one arm only behind the back suffices for all but very flexible figures, and for children the twist is apt to encroach too high. Therefore for such patients, and more especially, be it noted, for such as show even *the slightest tendency to dorsal* (**S**) *curve*, both arms must be so utilized; and more completely to immobilize the upper spine, a soft strap or bandage may be passed round both upper arms and across the back; or the palms may rest on the front of the chest, and an ordinary walking-stick may be thrust between the back and the bend of the elbow. These arrangements, consolidating, as it were, the upper segments of the spine and the chest into one piece none of the vertebræ there can rotate on one another; but all the twist takes place in the lower spine bones, which are left untrammelled, and these six or seven vertebræ (four upper lumbar, two or three lower dorsal) are, through the agency of this consolidated chest, turned on each other. That is to say, if the right direction of twist be chosen, the rotation in that region of the spine can be unfurled. Moreover, if he deem it advisable—but caution must be enjoined—the surgeon may grasp the protruding ends of the stick, and, using it as a lever, untwist the figure a little further than the unaided patient can manage.

But, as we have seen, and as is further insisted on in Appendix V., there are formed by contracture of muscles and ligaments on the concave side of a curve tight bonds, which I have compared to bow-strings and to tie-beams. No posture, no exercise, no iron cage, can overcome such obstacles to rectification. They, by the application of considerable force, must be stretched, and at first temporarily, and so by degrees permanently, restored to their rightful length and place. This method, which I have named 'rachilysis' (freeing the spine), is effected by pullies. The system I use consists of two blocks of four pullies

each ; thus, any force applied to the halliard exerts eight times its amount on the back—*e.g.*, a pull of a stone on the cord means a force of a hundredweight at a right angle to the chord of the curve, the direction of greatest mechanical advantage. By a broad webbing band attached to the legs of the stool, and passing across the seated patient's pelvis, that part is secured against slipping. Another

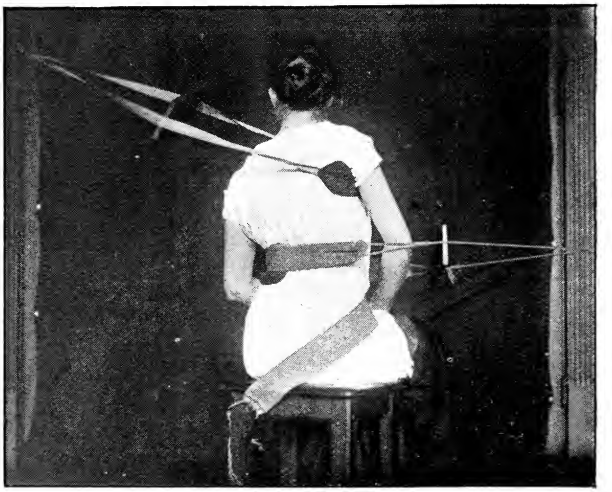


FIG. 30.—LUMBAR RACHILYSIS.

broad padded belt is placed on the left of the loin, an additional cushion being interposed, and the attached cordage hitched on the hook of the running block. Another loop, but of narrower webbing, padded where it lies in the right axilla, is secured to a cleat on the patient's left.* A broad wooden spline, about 2 feet long, keeps the front

* I now rarely use the stanchion shown in this plate between the laps of the shoulder loop, but place cushions on the chest to prevent uncomfortable pressure by the front piece of the inch-wide webbing.

and back cords of the loin tackle apart, thus guaranteeing the abdominal organs against compression. The pulley cord is then drawn on until a considerable amount of pressure is applied, and until some experience has been acquired the surgeon should use a dynamometer (a spring balance).

The method thus employed is entirely painless ; nevertheless, when first employing it, the application of pressure should be gradual, the question 'Does it hurt?' frequently asked, for the somewhat elaborate preparation is apt to scare young people, and by gentle initiation confidence will be inspired. Even with the most timid, pressure of 8 or 10 pounds on the cord, which means from 64 to 80 pounds on the loin, may generally be used. After a very little time almost any force is borne uncomplainingly ; but unless with a strong man or an unusually robust woman, more than between 14 and 20 pounds pressure on the cord—that is, from 112 to 160 pounds on the back—is unnecessary. The patient, as soon as she feels any fatigue, is to inform the surgeon, and he, loosening, but not removing, the tackle, lets her lean back on a cushion for three or four minutes, and then resumes traction. Rachilysis, save in slight cases, should at first be weekly, then fortnightly, and a certain impression being effected, longer intervals may be allowed. Meanwhile, one or more of the exercises above described should be sedulously practised.

In describing remedial exercises, several cautions against over-fatigue have been given, as also against the use of coercive chairs, etc., during the hours of study (p. 31). A further monition in the same direction may be added. As womanhood is approaching, or just reached, correctness and elegance of her daughter's attitudes engage the careful mother's mind, and with the more persistency, if she suspect the young lady of not being perfectly straight, and if she have heard, as is pretty sure to be the case, that spinal curvature may be produced by infelicitous positions.

Hence she is anxious that the young lady should ' sit up,' or ' sit properly.' Her corrective voice is, in many instances, too frequently raised, and I am sure often aggravates, even though it may not produce, the very evil, she is so anxious to avoid. One reason why boys are so much less prone than girls to curvature is that they are not subjected to such superintendence. Tired, they are permitted to assume such posture as they find most restful. Girls, fatigued by golf, tennis, or other exercise, resting on couch or easy-chair in unstudied repose, are immediately told to ' sit straight ' or ' not to sprawl,' and so upon their wearied muscles is thrown another task, which in a few minutes will be instinctively evaded by such kink or twist of the spine as will, though inconspicuous, relieve the tired organs (p. 32). Parental influence must, however, not be undermined, and an opportunity can easily be seized or made of explaining to the mother alone dissent from the dogma of æsthetic rigidity. Yet certain positions, such chiefly as have already been mentioned (p. 30), must be forbidden ; others less injurious may be more leniently treated, for it should be considered that most girls are sufficiently worried by necessary prohibitions ; to add superfluous ones may easily arouse recalcitrance, the more dangerous if it be occult.

But even though too great insistence on the above means of producing muscular weariness have been avoided, yet when the lumbar curve reaches a certain degree of intensity the weaker erector spinæ occasionally manifests by persistent aching over-fatigue. The locality to which this pain is referred is a part of the muscle near the origin—that is to say, at the back of the pelvis, close to the sacro-iliac joint. Many patients thus suffering indicate very definitely the place, others more vaguely. This pain is relieved, and after a certain time annulled, by the ' loin bandage.' Of course, each one is to be made to a pattern

cut in paper to the figure itself; but it is worn outside the underclothing, most conveniently over that form called a 'combination.' The bandage consists of a webbing strap passing round the upper part of the thigh, and made round where it lies next the perineum, by being drawn through an indiarubber tube, which again, is covered with kid or

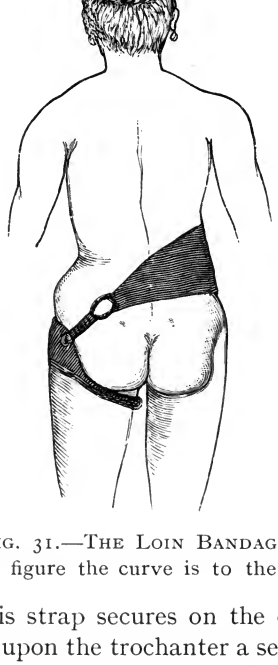


FIG. 31.—THE LOIN BANDAGE.
In this figure the curve is to the right.

wash-leather; this strap secures on the outer part of the ilium behind and upon the trochanter a semilunar portion.* This 'leg-piece' is merely a fixed point, from which the rest does its work. The rest consists of a well-fitting oblique portion, which is secured by a clasp to the back of the leg-piece; to the clasp is attached a webbing strap, which ter-

* Some patients are better fitted by a trapeze, small end downwards.

minates in a strong indiarubber ring, and thence a piece of moleskin, jean, or coutil, cut to pattern, sweeps round the loin, broadens considerably in front, terminating like the part behind in a ring and strap fixed to the front of the leg-piece.

Between the ring and the clasp, a buckle, with an arrangement to prevent the patient tampering with it, enables the surgeon to place and keep the tension aright. In putting it on, the back ring, that seen in the figure, should be considerably tighter than that in front, by which means there will be no tendency of the hip-pad to ride forward.

CHAPTER VIII

TREATMENT OF DORSAL CURVES

THE existence of a dorsal always connotes the presence of a lumbar curve, the lateral deviation and rotation in each being in opposite directions.* Therefore, any measure intended to straighten or untwist the upper must on no account be permitted to encroach on the lower segment, because whatever is in direction remedial of the one is necessarily, if it extend beyond rightful limits, injurious to the other. But the upper four lumbar and the two or three lower dorsal are the most movable of all the vertebræ of the trunk, and are therefore much more prone than are the upper nine dorsal to be affected by any position, exercise, or force, unless those agencies be carefully restricted within their proper bounds. The problem is by no means easy ; its solution has occupied much of my time and thought. The results have been partly given in preceding pages, but the most difficult part has been reserved for the present chapter, which cannot be called a mere chapter of remedial measures, for each suggestion made is the outcome of study and experiment.

The sloping seat (Figs. 24 and 25), described as valuable in lumbar, is only occasionally so in **S** curves, and chiefly for such cases wherein the loin is markedly less deviated than higher parts of the figure. But it is very difficult to

* The term 'dorsal' excludes total curvature.

predict without trial, in each particular case, its effect. This, therefore, should always precede its prescription. I have found that a small slope (1 in 14) used persistently has better effect than a wider angle for shorter periods.

The lateral sling is a powerful agent. Its mere construction has already been depicted (Fig. 21), and its value in both pelvic amesiality and in lumbar curves has been described. In employing it for dorsal curve, the locality on which the body-weight falls is different. The upper edge of the webbing girth must lie in the axilla, and the figure is to be placed obliquely, so that the stress of its support falls on or but very little outside the exaggerated

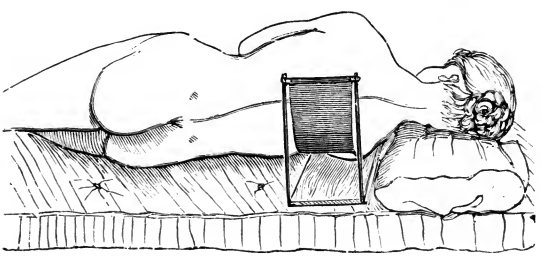


FIG. 32.—LATERAL SLING IN USE.

angles of the ribs. In this appliance, which is perfectly comfortable, the patient may read or sleep. The pressure acts at nearly a right angle to the chord of the curve.

The use of a plummet opposite a mirror in the bedroom while the patient straightens the nude figure (p. 49), and, learns the difference in sensation between what is a faulty and what a correct position, should be strongly insisted on; but, with some more indelible material than merely ink—for instance, with tincture of iodine—a line should be drawn at the centre of the xiphoid cartilage.

Exercises of the dorsal part of the erectores spinæ must be carefully watched. They are in three grades. The first

may be used on persons who have rather weak muscles. The patient sits on the sloping seat, high end to the left, and the padded loop of inch-wide webbing—that, for instance, used as the shoulder-piece in lumbar rachilysis—is passed over the head, and its mid-part, with also an additional cushion, is brought to lie on the right side at a level with the xiphoid cartilage, *on no account lower*. The cordage attached to the loop is secured to a cleat on the patient's left with such pull as shall render it quite taut. The left hand is then passed over the top of the head, the finger-tips touching, or very nearly so, the right ear. The patient then tries to bend the upper part of the figure, all that remains unrestrained, by the loop on her right. In the first few attempts little of such movement can be effected, but they should on each occasion be repeated at short intervals three or four times, and after several trials greater power of such flexion will be verifiable.

A similar exercise may also be practised in the horizontal position; it is in both its forms more exacting. Fig. 26 may be used to facilitate description, but the patient lies further down on the couch. Its end should be at the last four false ribs, and the cushion under the right side of chest and abdomen must therefore be longer—about 8 inches.* In the less strenuous form the right hand is removed from the floor and placed on the nape of the neck, and the upper segment of the trunk, without any impulse from the left arm, is to be bent as far as possible to the right. The next variety is more exacting, and may only be used for those who are gifted with some muscular power, or whose back has been strengthened by such precedent work as above described. The patient lies somewhat as in Fig. 22, but for right dorsal curvature on the left side; he also should be lower down on the couch, so that its end

* In both these exercises the knees should be somewhat separated, more fully immobilizing the pelvis.

is on a level with the tenth dorsal vertebra. A broad webbing strap binds, not tightly, the loin to the mattress ;* the patient then, lifting the hand from the floor and placing the palm on the top of the head, bends the upper part of the

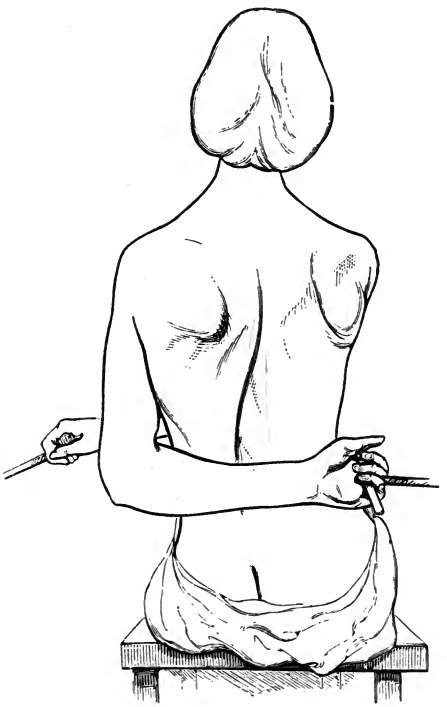


FIG. 33.—RESPIRATORY EXERCISE.

figure, all that is left free by the strap, as far to the right as possible. The bend is only to be maintained a few seconds, and is to be repeated from three to six times, according to strength.

* An arrangement like that which in Fig. 30 secures the pelvis to the stool is the most convenient.

An aphelic exercise devised by me many years ago, and called 'respiratory,' is here depicted. Into each of two opposite walls a hook or staple is driven, and to each of these is attached a cord ending in an accumulator and cross-handle. Midway between these hooks the patient sits.* The handle on the right is put into the left hand, the fore-arm crossing the loin; that on the left into the right hand, which is passed in front of the body, the cords being of such length as to exert a considerable drag on the hands. Thus arranged, the patient is to take several deep breaths at the rate of about four to the minute, and when the chest is at the fullest is to retain the air a little while. Expiration may be quicker, but not sudden. The posture and traction, by throwing out of gear the right, while increasing the power on the ribs of the left serratus, have great effect on rotated vertebræ, as is quite perceptible to one standing behind the patient. (See Fig. 33).

A manual method of combating dorsal rotation is, if used in the right way, valuable. It seems hardly desirable to inquire too closely as to who is responsible for a highly-injurious wrong way, which there is reason to fear is too much practised. In this false method the patient is directed to lie prone on a couch, while an attendant is to press with force on the prominent ribs. Whoever invented this overlooked that there is such a thing as counter-pressure, exactly equal to the pressure itself. This counter-pressure opposes and entirely prevents any untwisting of the spine, while to squeeze the already too sharply curved ribs between the hands and the mattress will greatly diminish the size of the right chest by forcing the bodies of the ribs and the vertebræ still nearer together.† If the

* The sitting posture prevents twist of the pelvis. In certain cases where lumbar curve is well marked the sloping seat should at the same time be used.

† These parts are in severe cases only $\frac{3}{8}$ inch apart (p. 43).

reader, while pondering these considerations, will look at Fig. 6, and more especially at Fig. 42 in the Appendix, which is placed on the page in the position the patient by the above proposal is bidden to assume, he will be unable to resist the conviction, that the procedure just explained, must be absolutely avoided. Nevertheless, manual correction of dorsal rotation is valuable, provided that almost all the arrangements described in this paragraph be entirely reversed.

Instead of prone, the patient lies supine, and under the backward projecting ribs of the right side a firm cushion, or, better, a moderately-filled sand-bag, about 8 × 4 inches, is placed, and pressure is applied, not on the right back, but on the left front. There are several ways of effecting this : the most efficacious, but at the same time the most complicated, and not always applicable, is as follows : Over the couch, suspended from the ceiling or elsehow, is a cord with a cross-handle so placed that the latter hangs a little outside the right shoulder, at such a height that when grasped by the left hand the shoulder and thorax of that side is slightly lifted from the couch. An attendant is then to press the front of the left ribs backward, the power being exerted over a large surface, extending down to the eighth rib, and from a little in front of the mid-axillary line to about 2 inches from the edge of the sternum ; and if at this place* there be a rounded ridge formed by a bend of the costal cartilages, this should be pressed by firm, but not ungentle, force backward. The reason for suspending the cord a little beyond the patient's right is that in grasping it the patient turns his trunk a little over upon that side,

* In severe cases, such as for this method are postulated, the left costal cartilages are too straight till they nearly approach the margin of the breast-bone ; they then slope rather sharply back, making an angle supplementary to or compensating the exaggerated angle at the back of the right ribs.

placing it in that position in which both pressure and counter-pressure act most advantageously for untwisting the morbid dorsal rotation. If the cordage, etc., cannot be arranged, the patient should lie with the left hand on the lower costal cartilages.

It is generally desirable to employ the more potent methods, not merely when muscles are passive (recumbency), but also when in action, as in sitting or standing. In the former position the male and often the female patient may sit astride a chair, facing the back, and immobilizing the pelvis by gripping the seat between the knees and by placing the right hand on the chair-back, resists any tendency to force the whole figure forward. Pressure is then applied to the right rib-angles. In the erect posture pressure on the backward-protruding ribs requires no other apparatus than a round wooden staff, 1 inch or so in diameter, and about 16 or 20 inches long. One end is cut off obliquely (about an angle of 70 degrees), and to it is screwed a board about 7×4 inches for full-grown persons. The patient stands facing a wall, against which she stems one end of the staff, while the padded board at the other end is placed on the right side of the abdomen, so that it overlies the two lower costal cartilages and the anterior superior spine of the ilium. The left palm is then put on the wall at a level with the clavicle. When thus arranged, the attendant presses the backward-protruding ribs forward, while the patient makes deep, slow inspirations (expiration may be quicker). The pad and staff, placed as above, entirely obviates any possibility of pelvic movement during the applied pressure, also of its trespassing below the eighth dorsal vertebra and affecting the movable ones that lie lower down, while its aphelic power on the higher segment of the spine is very considerable, and its effect of straightening out the crumpled rib-angles, especially in young people, is well marked.

Rachilysis is also valuable in **S** curves, and may be used

in two modes. Fig. 30 will serve to illustrate the milder method; but the loin-loop, adjusted higher on the body, is to become a dorsal one, its upper edge lying close under the axilla, the cushion on the prominent rib angles. Fig. 34 depicts the more potent, though quite painless, form. A dorsal and also a lumbar loop are used, and to each a pulley-sheaf is attached, so that both segments of the spine are pulled into curves contrary to the morbid ones; seldom,

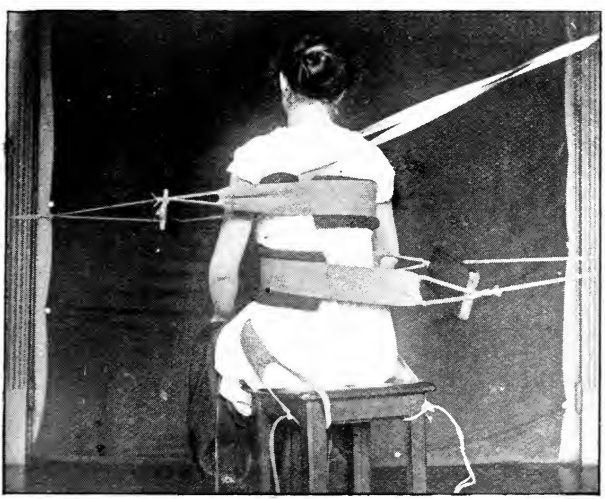
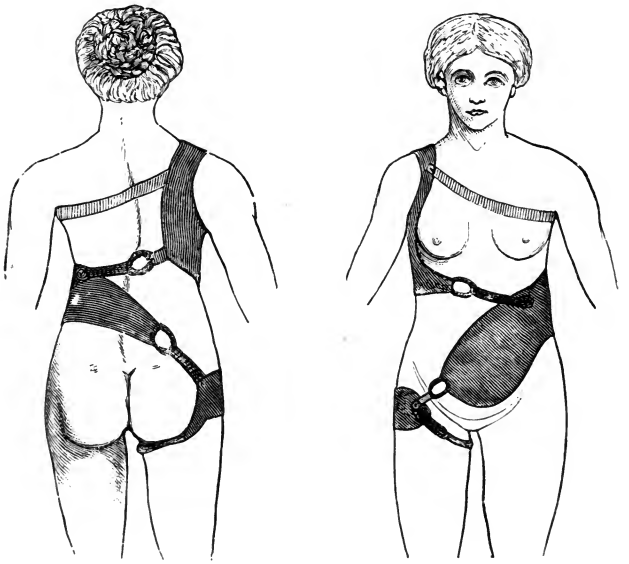


FIG. 34.—DORSO-LUMBAR RACHILYSIS.

it is true, on the first few occasions, but usually about the fourth or fifth that result is obtained. The character of the opposition during these first few applications of the force should be noted; a hard, rigid resistance evidences, though it does not quite prove, the presence of ligamentous tie-beams. (See Appendix VI.)

Certain patients with marked rotation of dorsal vertebræ complain of pain at a spot between the base of the scapula

and the spine. It is caused by over-fatigue of the larger rhomboid muscle (see Appendix IV.) The bandage which, many years since, I introduced under the name of 'dorso-lumbar,' relieves it entirely after a few days' use (Figs. 35 and 36). Nevertheless, for that sole object, and unless the pain be unusually severe, so powerful an appliance may often be omitted, a mere sling sufficing. Every lady



FIGS. 35 AND 36.—LUMBO-DORSAL BANDAGE.

knows how to arrange an inconspicuous ribbon or scarf about her garments in such wise that when this pain supervenes she may support in it her arm, and so relieve the rhomboid and serratus of one of their tasks—support of the shoulder and arm.

Although, as just said, the bandage above named is more than is necessary for preventing the pain above described, yet it is valuable in severe curvatures in counter-

acting the deviation and rotation in both back and loin. It consists of the lumbar bandage described at p. 68, with the addition of a shoulder-piece, as here depicted. It will be noticed that every strap is rendered elastic by intercalation of strong indiarubber rings, so that in no sense or direction is there coercion of a rigid nature, but only persuasive resilience. The upper strap, which consists of inch-wide elastic webbing, merely keeps the shoulder-pad in place. In putting it on, the surgeon must teach the patient that the back rings—those visible in Fig. 35—must be pulled tighter than the front ones. Patients with severe **S** curve suffering from distressing weariness find the bandage exceedingly comfortable.

Neither surgeon nor patient should allow themselves to be disheartened during the early phases of treatment by tardiness of progress; the dorsal vertebræ are far less mobile than the lumbar, on account of the attachment of ribs to two centra and also to transverse processes. Nevertheless, when a certain freer response to remedial measures has taken place, improvement generally becomes much more marked even in more mature subjects; but chiefly in those under twenty-two the form of ribs alters considerably.

APPENDIX I

THE VERTEBRÆ

The spinal column consists of twenty-four bones (omitting sacrum and coccyx), superimposed on each other. Each vertebra may be divided primarily into a body (centrum) and backward-projecting processes, the former being the more massive, and supporting by far the larger part of the superincumbent weight. The processes consist of a pedicle and laminæ, which arch over and enclose the spinal cord ;

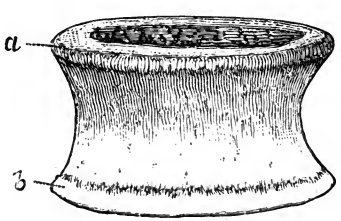


Fig. 37.—A Vertebral Centrum shortly before Epiphyseal Union.

a, Upper epiphysis ; *b*, lower epiphysis.

they also afford bases for the articular, the transverse and the spinous processes. The use of the first is to direct and limit movement, thus minimizing the chance of dislocation ; the second and third are chiefly for affording projections and surfaces for muscular attachment. Though, when mature, every vertebra is a bony unit, in early life each consists

chiefly of cartilage, becoming slowly ossified from various centres, so that in, and even beyond, infancy each consists of several bones, separated from one another by cartilage; thus the centra are formed not only of the chief mass, but also of two thin plates constituting the upper and lower surfaces. The line of uniting cartilage only disappears about the twenty-sixth year. The complete union of different parts of the processes to each other and to the vertebral body is also a late event.

The main piece of the centrum and the thin upper and lower addenda, termed epiphyses, are here depicted. Growth of the bone in thickness early in life takes place at first by increase of the whole central mass, a little later by addition to the lines of union. If in any bone weight be unevenly distributed, so that more pressure fall on one than on the other side of a growing junction, that side will increase less, the non-weighted side more than normally; hence lateral curvature beginning in early life, unless quite slight, renders the vertebræ wedge-shaped—*i.e.*, thinner on that side which subtends the concavity.

APPENDIX II

THE LIGAMENTS

THE bodies of the vertebræ, though superposed, are not in contact, but are separated from each other by intervertebral discs strongly attached to the upper and lower surfaces of the bones; they therefore act as means of separation and as bonds of union. They are made of concentric rings of fibrous tissue surrounding a central cushion of more jelly-like material; they are easily extensible, but hardly yield to pressure—that is to say, they allow this weight-bearing part of the column to be lengthened, but resist shortening. Also binding the bodies together, are the anterior and posterior common ligaments, composed of white fibrous tissue. The former of these, broader at the lower than at the upper part of the spine, lies in front of the vertebral bodies, is more closely attached to the intervertebral substances than to the bones, and is composed of several layers. The more superficial fibres, being the longest, pass between their points of attachment over five or six vertebræ; the deepest only run from one bone to the next adjacent intervertebral disc. The posterior common ligament lies within the spinal canal on the hinder aspect of the bodies; with the exception of its situation, and of the fact that it is broader above than below, its properties are the same as those of the anterior. The laminæ are bound together by very strong bands of

yellow elastic tissue (the ligamenta subflava); the peculiarity of this material is its great tendency to, and power of retraction, while, even though considerable force be employed, it can be but very little lengthened. So powerful is this retractile power of the yellow ligament that it is said to 'serve to preserve the upright posture, and to assist in resuming it after the spine has been flexed.'*

The only other ligament needing mention here is the supraspinous, a strong cord-like band of fibres extending from the seventh cervical vertebra downward throughout the whole length of the column.† It is stronger in the loins than elsewhere, and will not permit of extension (lengthening).

* Gray's 'Anatomy,' p. 167, 11th edition.

† It is not wanted in the neck, its function being assumed by the ligamentum nuchæ.

APPENDIX III

CAUSES OF ANTERO-POSTERIOR BENDS

THE spines of quadrupeds are slightly curved from the last cervical vertebra to the pelvis, the concavity looking downward (forward). Even those creatures, which occasionally assume a vertical position, do not alter that form, though they change the direction of the whole column. Man is the only mammal, whose spine normally curves backward and forward alternately in its three regions ; he likewise is the only one, whose erect posture is such that the long thighs stand in the same general direction as the mid-line of the trunk ; also the only one, the axis of whose pelvis diverges backwards considerably from the general axis of the figure. These peculiarities are thus correlated. The bends or curves of the infantile spine are quite indifferent—that is to say, the column takes the form of any surface, on which the baby is laid. The thighs are kept almost constantly bent, up to a period between the ninth and twelfth month of viable life ; the pelvis does not slope—that is, its brim is nearly at a right angle to the spine*—and it is not until the child, in trying to stand, stretches down the thighs, that the pelvis assumes a backward slope, and that the sacrum slants from above backward and downward, necessitating that natural curve of the loin, which prevents the figure

* When a baby ' stretches,' which act includes extension of the thighs, the pelvis slopes in such wise that the tuber ischii recedes, the anterior spines of the ilium advance.

slanting forward, as is the manner with the semi-erect anthropoid apes, walking on their hind feet. The change in the lumbar spinal column is the immediate and inevitable result of the backward slope of the pelvis, and this, in its turn, is due to the straight position of the thighs in station. When the infant abandons the quadrupedal and baby habit of constantly flexed thighs—when in trying to stand he straightens the thighs and places them nearly parallel with the mid-axis of the figure, he by this act drags on all the fasciæ and muscles, that pass over or from the front of the pelvis to the femur—on the fascia lata, rectus pectineus, ilio-psoas, etc. These, by pulling down the os pubis, produce the human slope of the pelvis, and, as a resultant, necessary for balance, the antero-posterior bend of the loins. Also, the fibrous structures that run from pelvis to costal cartilages and sternum aid, by traction on the latter, in forming the dorsal bend in the reverse direction. The curve of the neck (concavity backward), constant in the human erect posture, save in looking down, as in reading or writing at a table, is also caused by the relative position of anatomical parts. The location, behind the great foramen, of the occipital condyles, on which the skull rests, is a long way behind the centre of gravity, and the head would fall forward but for the action of fibres—chiefly of muscular fibres —attached behind the foramen magnum, which, as they lie some distance posterior to the occipital condyles, also bend the cervical spine (concavity backward). Forward preponderance of the head is also largely counterpoised by suspension of much shoulder-weight to the most posterior part of the occiput, through the medium of the anterior and upper fibres of the trapezius muscle. This of all the muscles in the nape lies furthest back, therefore mechanically is in the most advantageous position, not only to counteract by mere tonic tension the forward trend of the head, but also to produce the curve of the neck in the direction already described.

APPENDIX IV

ACTIVE ROTATION

VOLUNTARY or emotional rotation of the spine—as, for instance, when the individual turns to look at some object behind him, to follow with the gun a bird flying across or to pursue almost any field sport—is a very frequent, but essentially a transient, action. The longitudinal muscles —*e.g.*, the erectors and the legion-named muscles which fill the vertebral groove—cannot effect this movement; to do so requires one whose fibres run more or less across the axis of the column. In seeking for the organ which really twists the body as above described, I first noticed in a girl of about fourteen seated on a stool, that when at my request, she tried to see objects behind her, the lower part of the serratus magnus underwent strong contraction. Fig. 38 represents the back of a youth about twenty years old, strapped to the stool on which he is seated, both arms being crossed so that each hand rests at the bend of the elbow, and he is turning the body to the left so strongly that the plane of the chest forms an angle of about 35 degrees with that of the pelvis. In the photograph, then taken, two lines may be observed, running obliquely from the lower angle of the scapula to the side of the chest-wall: the lower of these is that thick, strong part of the serratus, which originates at that angle of the bone; the upper one is the septum dividing that part of the muscle from the

thinner membranous portion which arises from its general border (the base). This muscle, therefore, is the chief instrument of voluntary rotation.* In order more fully to realize this power of the serratus, the reader should bear in mind the method of rib attachment to the spine;

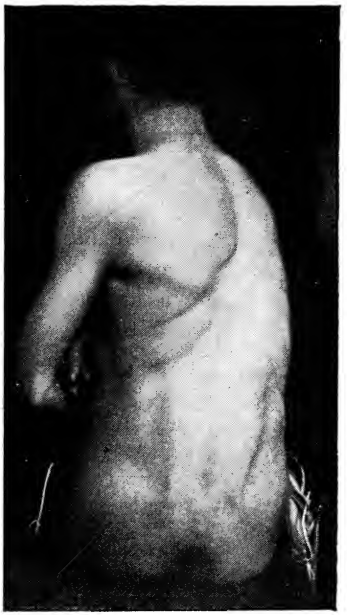


FIG. 38.—LEFT SERRATUS MAGNUS ROTATING THE FIGURE.

all the upper ten articulate by their heads with the vertebral bodies, by their tubercles with the transverse processes. Thus the serratus uses each rib as a lever of the second order, the fulcrum being at the head, the weight at the tubercle, the power-arm extending from the head to

* The reader is requested also to refer to Fig. 29 in Chapter VII., where the same muscular marks are conspicuous.

the insertion of the muscle in question. This arrangement gives to the serratus enormous mechanical advantage in turning the vertebræ, and as though still further to accentuate the purpose, the double articulation of ribs to spine ceases when the muscle is no longer inserted into the former bones. The subjoined case well illustrates the rotation power of this muscle. The fact that the young man used it in an exceptional manner does not detract from its value as an example.

Mr. ——, aged nineteen, came to me on February 9, 1867, with a far-advanced dorsal curve to the right. He was by no means weakly, but on the contrary muscular, being used to strong exercise, more especially with the dumb-bells. Rotation was very marked, the right ribs and the lower angle of the scapula projecting very much backward ; but there was something very peculiar in the distortion ; it bore markedly all the characteristics of a weight-bearing curve, with the exception of a very characteristic feature—the strong development of the left sacro-lumbalis and longissimus dorsi. It is true that he confessed to using the dumb-bells rather more with the right than with the left hand ; but in all my previous cases I had always found such or similar work produce with the curve that muscular prominence. The condition was, to my mind, so anomalous that I re-examined all my minute records, my photographs, and my theory of lateral curvature. On his second visit I observed this peculiarity of attitude : he always stood with the right hand placed far back on the hip or on the loins, and threw his elbow as far back as possible. I kept him with me as long a time as I could spare, and standing as much as possible. He maintained constantly this attitude ; and, on questioning him, I found it was habitual. Thus, then, was my difficulty not only solved, but a singular proof added to my observations on the rotating power of the serratus. This position, by throwing back the base of the scapula, caused that muscle to drag upon the ribs ; and not only the absence of an extra burden, but the fact of his supporting the weight of the trunk on the right hand, precluded the extra development of the left erectores spinæ.

Besides this rotating power, the serrati are the most potent agents in keeping the chest wide—in preserving a longer diameter from side to side, rather than permitting the quadrupedal form of a greater depth from behind forwards. The two muscles effect this by opposing what otherwise would be the narrowing action of the diaphragm, which more or less at each, but especially at every deep inspiration, tends to drag the ribs of its origin (the six lower) inward upon the cavity.

This of necessity leads to some considerations as to whether this pair of muscles has any part in respiratory movements. Everyone knows that Sir Charles Bell attributed a large share of the breathing function to this muscle; also that since 1871 those views have been much discredited, partly by certain observations, that paralysis of the muscle has not produced dyspnœa (Oscar Berger), partly by failure to excite in rabbits deep inspirations by faradaizing the serrati (Traube). The former argument is invalid, for so large a number of muscles participate in the breathing function that loss of one (save the diaphragm) is easily compensated by several others. The same author further weakens his deductions, by denying to other important muscular groups all participation in respiration. In regard to electric stimulation in rabbits, it must be noted that the differences in form of the chest and in position of the scapulæ, contrasted with man, render the experiment exceedingly indecisive. Duchenne found, in faradaizing the serratus of a man, strong evidence of inspiratory action.* It may well be conceded that Bell somewhat exaggerated the respiratory function of the serratus, but he is nearer the truth than his sceptical critics.

Studying all the actions of this muscle, the two rhom-

* This subject is more fully worked out in the fifth edition of my work on 'Spinal Curvature,' p. 175 *et seq.*

boids and the serratus are to be regarded as a broad muscular layer enwrapping the side of the chest, having a movable intersection—the base of the scapula. Like the above - described, they follow the same tendency to recede towards the chord of the curve, or, more correctly, it may rather be said that the bones, becoming curved and gliding away from the straight lane, leave the longer fibres of the muscles behind them to take a more direct course. These other bow-strings very soon adapt themselves to the new shortness between the points of origin and insertion. The methods whereby the presence of such bonds may be, if not actually diagnosed, at least strongly surmised, are indicated at p. 95. Their existence, or perhaps I should say the mechanical necessity of their existence, seems to have been overlooked by writers on spinal deformity.

APPENDIX V

PASSIVE ROTATION

Passive rotation—that, namely, which occurs in lateral curvature—is not produced by effort, but by the different constitution as to extensibility and contractility of the vertebral ligaments. A scoliotic spine does not merely sway to right and left of a normal middle line, but is twisted spirally round it. Let this line be imagined as a straight staff; in lateral curvature the spine is curled round it like a tendril of hop or vine (see Fig. 39). In order to compute the relationship between lateral deviation and rotation, I made, several years ago, a series of experiments on human spines carefully cleared of all soft parts except the ligaments, the fifth lumbar vertebra being firmly clamped in a vice. Through the costo-transverse foramina of the atlas were passed cords, each bearing a hook for the suspension of weights, and each playing over pullies, so placed as to give the greatest mechanical advantage in bending the column sideways. Also, through those foramina other cords were threaded, each bearing a small plummet.

A spine, measuring 23 inches, thus prepared, being bent so far sideways that the plummet hung 5 inches from the centre of the fifth lumbar vertebra, measured along the convex side 23·65 inches, on the concave 22·4. Another, a very long spine, measured when straight 24·1 inches, so bent laterally that the plummet lay 6·5 inches from the

centre of the base ; it measured 25·3 inches on the convexity, and a fraction under 24 inches along the concave side. When either of these spines was bent sideways to so small a degree that the plummet stood away from the centre of the base only 2 inches, or less, no rotation of vertebræ was perceptible. When lateral flexion exceeded

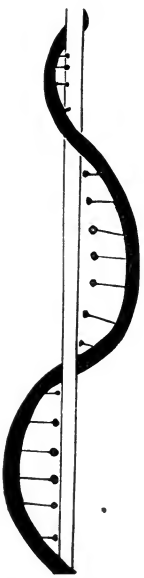


FIG. 39.—SPIRAL TWIST OF SPINE.

this amount rotation set in, and increased in degree commensurate with the amount of bending.

The correlation between sideways flexion of the spine and rotation is, as above said, due to the essential differences in the quality of the various ligaments, especially to those between the intervertebral discs and most ligaments of the processes. As the discs are recalcitrant to compression, they must, when the spine is bent sideways, seek the

longest line of the curve (convexity) ; while the ligaments which refuse to be elongated—those, namely, of the pedicles, laminæ, and spinous processes—take the shortest road, keeping themselves and the points of their bony attachment in as straight a line as possible, or at least in the shortest swerve of the curve (concavity). The annexed diagram represents the tendril-like twist of a scoliotic spine round a normal middle line, portrayed by two nearly parallel straight strokes ; the bodies of vertebræ by a broad solid black line, from which project spinous processes (short thin marks), their tips being indicated by black dots. In the corkscrew-like twist of the column the anterior, or what in a normal spine are the anterior faces of the vertebræ come to lie very laterally (compare Fig. 40), and perform a very wide gyration—that is, they lie on the most deviated aspect of the curve, forced thither by the resistance to compression of the intervertebral discs. The ligaments of the processes resisting elongation compel those parts to occupy the shortest road—*i.e.*, to lie in the concavity. Especially must attention be drawn to the cord-like supraspinous ligament firmly restraining the tips of those projections, and thus causing them to lie in straighter line than any other part of the column. This is the reason why the row of those long bony points (see p. 2) must not be taken as of much diagnostic value.

APPENDIX VI

TIE-BEAMS

THOSE ligaments, which are made of white fibres, will not long remain loose. On the contrary, when, by malposition, the points of their attachment are persistently approximated, the tissue shortens itself to such extent as shall re-establish the normal amount of its tension. Hence these abbreviated ligaments become bonds, tying the deviated bones into the curved position. Moreover, a very important change affects the anterior common ligament.* As was explained in Appendix II., the superficial fibres of these structures, passing over several vertebræ, are at least six times as long as the deepest ones, which run only from one bone to the next one, or to the adjacent intervertebral disc. To facilitate explanation, it may be supposed, that all the vertebræ of a curve involving the four upper lumbar and two lower dorsal, slope on the ones next below, in equal degrees. That means the fourth lumbar deviates on the fifth by, say, 5 degrees, the third on the fourth by the same amount, and so on to the eleventh dorsal. Thus, though each vertebra slants on the next lower by so small a gradient, yet deviation of the series amounts to 30 degrees, and the most superficial fibres of the ligament in question stretch from bottom to top of the curve. The common connective tissue, that attaches those longest

* Probably also the posterior.

fibres to the next deeper layer, compels them to a certain extent and for a time, to follow the osseous deviation; yet that extensible tissue soon yields and permits the superficial fibres of the common ligament to take a shorter course—one approximating to the chord of the curve. The other deeper, and therefore shorter, fibres also partake, but of course to a smaller degree, in the same change. This necessarily connotes that the ligament recedes from that which normally is the anterior face of each vertebra, and takes up position in the concavity; or it might be more just to put the matter differently, and to say that the spinal bones, deserting the correct middle line, leave nearer to the correct position most of the common ligament, the fibres of which, since they take an abnormally short course, are for a time loose. But, as just said, the sort of tissue, composing this ligament, will not remain loose, but tightens and thickens; thus there runs, in the concavity of the curve, and much in the direction and place of its chord, a strong contractured band, which may aptly be compared to a tense bow-string or to a tie-beam. This condition was revealed to me several years ago by a very restricted autopsy I had the opportunity of making. I could feel rather than see, in that small dark room, that the edge of the anterior common ligament stood some distance from the opposite vertebræ, and that its border was thick, hard, and tight, the sensation conveyed to my finger reminding me of Gimbernat's ligament in femoral herniotomy. The ligaments of the arches undergo similar modifications.*

The strong longitudinal muscles of the back,† conveniently classed together as the erectores spinæ, lie pair-wise behind

* The other ligaments, those attached to the various processes, also become changed, elongated on one side, abbreviated on the other, but their condition need not be further described.

† From within outwards the spinalis dorsi, longissimus dorsi, ilio-costalis.

and on the side of the vertebral column. Like the common ligament, they follow the same tendency to adopt the shortest course, and on the concave side to glide towards the chord of the curve, and they very soon adapt themselves to the new shortness between their points of origin and insertion. The existence of both species of tie-beam is a very important factor in scoliosis, though it seems to have been much overlooked by writers on that subject.

APPENDIX VII

OSSEOUS CHANGES

THE deformation of bones in scoliosis is very singular, but it would be incompatible with the object of this work to describe them in great detail.

The vertebral centra are in old cases found wedge-shaped—*i.e.*, thinner on the side subtending the concavity than on that next the convexity; whether such occurs when the curvature begins about or after the age of eighteen (supposing such late commencement verifiable) is more than doubtful. Fig. 40 shows this cuneiform deformation.* The bones are of a person beyond middle life, but the deformity has evidently existed very many years, probably since childhood. The parts behind the bodies—pedicles, laminæ, and the various processes—also undergo changes of form, lengthening, shortening, and deflection, by careful study of which it is not difficult to trace the forces producing them; the subject, however, lies outside the purpose of this work, and it is sufficiently discussed in the fifth edition of my work on lateral curvature. It may, nevertheless, be well to subjoin a plate showing the altered forms, for curious changes affect the ribs. Those on the convexity of the curve are crumpled; not only are the angles abnormally sharp, but also the whole length of the body is much too

* Rotation also is well depicted.

strongly bent, the result being that the anterior end of the bony part is much too near to the body of the vertebra, and the space enclosed is narrow and compressed, as is

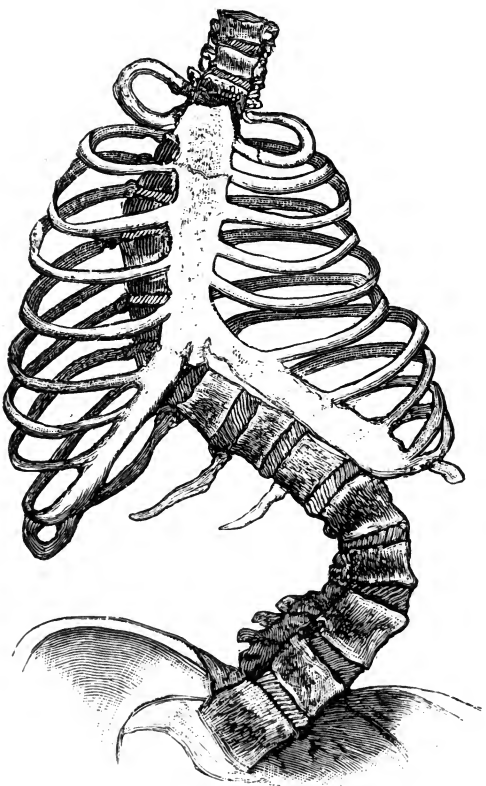


FIG. 40.—SCOLIOTIC SKELETON.

seen in the figure. Also, it should be noted that the direction of the first part—that is, from head to angle—is much too backward.

The contrary modifications prevail on the concave (left)

side. The rib is very much straightened out, its angle effaced; the chief bend, instead of being at the angle, is

FIG. 41.—SCOLIOTIC FIFTH DORSAL VERTEBRA, SEEN FROM ABOVE.

within a short distance of the anterior end, and that end is far removed from the vertebra; the space enclosed is wide.

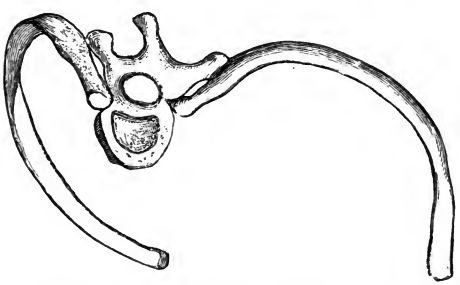


FIG. 42.—THE FIFTH THORACIC RING (AFTER LORENZ).

The reader, while looking at this plate, should reconsider and refer to a mode of treatment deprecated at p. 74.

APPENDIX VIII

CHANGE FROM TOTAL TO S CURVE

The **S** curve may occasionally be the initial malformity, but in my experience is much more frequently the result of a change in a total curvature so rapid as almost to deserve the name 'sudden.' It is an early event in severe cases, and from observations I have had fortunate opportunities of making, I ascribe it to disturbance of balance in excess of mechanical tolerance. A total curvature to the left may be taken as example—that is to say, the spine from the fourth lumbar to the first dorsal. As long as the slope is moderate, balance is easy, but the facility ceases when the postural obliquity has reached such a degree that the corporeal line of gravity falls outside the left foot. In such event the difficulty is overcome by throwing the upper part of the figure to the left, thus producing in its dorsal division a curve convex to the right, while the lower half of the trunk still maintains its left curvature; that is to say, the simple curve to the left has become modified into the **S** curve—lumbar to left, dorsal to right.

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THE END

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